IMAGINATION IN MOTION:
PRETENSE REPRESENTATION AS PERCEPTUAL SIMULATION

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The current study examined the role of motor and visual perceptual input for 20 and 28-month-old toddlers' emergent pretend play representations. Action was hypothesized to guide and support toddlers' representations in pretend play. Ninety-seven toddlers aged 20 and 28 months were tested on a task adapted from Tomasello, Striano & Rochat (1999) in which they fed a stuffed worm pretend replica and substitute toys. Both motor and visual perceptual inputs were manipulated. Motor input played a significant role depending on the type of pretend play toy. With replica toys, motor perceptual input had little effect on toddlers' ability to comprehend and reproduce play with replica toys. However, with substitute toys, which are visually dissimilar from their referents, toddlers comprehended the task only when they had a combination of motor input from their own and others' actions. Findings are discussed in terms of common coding theory and DeLoache's dual representation model. A modification of the paradigm is also proposed.

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PREFACE

I would first like to thank the local child care centers for allowing me to conduct the project in their classrooms. I learned so much by observing the teachers and am very grateful for their support and assistance. My special thanks go to all of the toddlers for their help and cooperation with this project and the parents who volunteered their children's time to participate.

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1.0 INTRODUCTION

The second year of life marks one of the most remarkable and exciting periods in all of human development. This year sees dramatic developments in children's social skills and social understanding. Children become capable of communicating with others through language (Clark, 1993), understanding the intentions of others' actions (Meltzoff, 1995), and coordinating their attention and actions with adult (Barresi & Moore, 1996; Tomasello, Kruger, & Ratner 1993) and peer partners (Brownell, 1988; Howes, Unger, & Smith, 1989; Smiley, 2001). Not least among these social-cognitive accomplishments is children's emerging capacity to become absorbed in an imaginative world of their own choosing (Fein, 1981; Harris & Kavanaugh, 1993). Children's ability to engage in pretense represents their first introduction into the uniquely human worlds of fiction, fantasy, and make-believe (Barresi & Moore, 1996).

The last 30 years have seen great theoretical and empirical interest in our understanding of the development and cognitive architecture of pretend play. Research on young children's pretend play competence has also been marked by significant debates on which forms of representation are necessary and sufficient for pretense (Harris & Kavanaugh, 1993; Leslie, 1987; Lillard, 2001; Nichols & Stich, 2000; Perner, 1991; Tomasello, Striano & Rochat, 1999). These debates often take the form of yes or no questions about children's capacity for pretend. Is meta-representation necessary to engage in pretense or not (Leslie, 1987; Perner, 1999)? Do 18 month olds to 3 year olds' apparent pretend play engagement reflect sophisticated cognitive understanding of pretense actions (Rakoczy & Tomasello, 2006) or do they merely have a superficial understanding of their own and others' pretend play actions ("behaving-as-if" theory (Harris, 1994; Jarrold, Carruthers, Smith & Boucher, 1994; Lillard, 1994)? At the heart of all these debates have been two questions, "Do young children understand pretense or don't they?" and, "At what age do they understand?"

The drawback to framing questions about toddlers' pretense competence as a binary, "yes or no" problem has been driven primarily by the assumption that children's pretense cognition is largely independent of the environmental context in which it occurs and that pretense representations precede and drive pretense actions. However one drawback to framing questions in this way is that it does little to explain age-related variation in tasks of toddlers' and preschoolers' pretend play comprehension. For example, although children first begin imitating pretense actions by 18 months of age (Watson & Fischer, 1977), and correctly follow directions to engage in pretense by 26 months of age (Harris & Kavanaugh, 1993), they do not appear to be capable matching pretense toys to their referent objects until 35 months of age (Tomasello et al., 1999). Moreover, only by 4 or 5 years of age, do children correctly report that a character with no knowledge of rabbits and no intention to act like a rabbit is not pretending if it is hopping up and down like a rabbit (otherwise known as the "Moe" task; Lillard, 1993, 1998; Richert & Lillard, 2002).

1.1 EXPLAINING CHILDREN'S PERFORMANCE ACROSS PRETENSE TASKS

If the capacity for pretense is conceptualized as something children either have or don't have, the discrepancies found across these tasks make little sense. If children understand pretend play enough to imitate it (Watson & Fisher, 1977) or follow pretense instructions (Harris& Kavanaugh, 1993) by the time they are toddlers, why do they fail so abysmally on other tasks of pretence competence until they are preschoolers (Tomasello et al., 1999; Lillard, 1993, 1998). Indeed, such variability in children's performance across paradigms is often attributed to methodological inadequacy in assessing toddlers' "true" capacity for pretend play. Researchers have questioned whether experimental paradigms utilizing imitation (Harris & Kavanaugh, 1993; Tomasello et al., 1999) or verbally prompted action (Tomasello et al., 1999) could ever provide valid assessment of toddlers' capacity for pretense representation. They have also questioned whether 18 to 26-month-old toddlers' performance can be explained by lower level cognitive mechanisms such as blind mimicry (Harris & Kavanaugh, 1993), simply following directions (Tomasello et al., 1999) or "behaving-as-if" they are pretending (Lillard, 2001). Others have questioned whether a task (e.g. such as the "Moe task") which requires verbal report is too verbally complex to be a true measure of toddlers' and preschoolers' understanding of the necessary and sufficient criteria for pretend play (Rakoczy & Tomasello, 2006).

Instead of conceptualizing the capacity for pretense representation as a one-time cognitive achievement, young children's varying performance on these different pretense tasks could also reflect *how* pretend play representations develop and in which environmental conditions children's competence for pretense can shine. Which contextual elements support the most primitive forms of pretend competence? Rather than making a case that just one of these studies accurately measures toddlers' "true" capacity for pretend representation, perhaps all of them can provide "true" measures of the development of pretense representation depending on which contextual factors are present. For example, children imitate pretense actions with toys that are similar to their referents (replica toys such as a toy phone) than with toys that are more visually dissimilar (substitute toy such as a banana; Tomasello et al, 1999; Watson & Fisher, 1977). Both of these imitative actions could reflect true pretend competence with varying levels perceptual support. Viewed from this perspective, the pattern of age-related variation across these differing tasks provides insight into the contextual factors which support early pretend play cognition and the ways in which children's pretense representations develop (Siegler, 1994).

What contextual factors could explain this pattern of results? One likely candidate is children's opportunity for action during tasks of pretense comprehension. In addition to the methodological differences between the previously summarized pretend tasks, these tasks also differ in the opportunities they give children to engage in actions with pretend toys. Thus, correspondingly, they also differ in the amount of direct motor perceptual input children receive during the comprehension task. Children first appear to understand pretend at 18 months when they are fully physically engaged in the pretend play task through imitation (Elder & Pederson, 1978; Fein, 1981; Jackowitz & Watson, 1980; Watson & Fischer, 1977). They later demonstrate pretend competence at 26-28 months when acting on the direction of pretense instructions (Harris & Kavanaugh, 1993), or matching pretense toys to an action (Tomasello et al., 1999) or completing unfinished pretend actions (Rakoczy & Tomasello, 2006). Finally, they show pretend competence also at 4-5 years of age when engaged in a verbal task in which no action is needed (Lillard, 1993). Hypothesizing that action supports pretense representation may explain the pattern of results seen across pretense comprehension tasks.

Could children's actions with toys and corresponding motor perceptual input support their pretense representations? Current pretense theories would answer "no." They propose a traditional view of representation as cognition that exists independent of perceptual input and assume that children's pretense representations both precede and serve to guide and direct their actions in play. Action is described as "optional" for children's pretend play engagement (Lillard, 2001). However, in recent years this traditional view of representation has been challenged in the emerging field of embodied cognition theory and research.

1.2 EMBODIED COGNITION

Embodied cognition theories of perceptual symbol systems (Barsalou, 1999), situated action (Glenberg, 1997; Damasio, 1994), and dynamic systems (Thelen & Smith, 1994) extend and re-conceptualize traditional views of representation (Markman & Dietrich, 2000) by maintaining that cognition, including pretense representation "arises from bodily interactions with the world and is continually meshed with them" (Thelen, 2000). Although different theoretical models emphasize different aspects of embodied cognition and use different terminology, they share common principles that depend on a tight link between the processes of perception and representation (Wilson, 2002). Therefore, unlike the traditional assumption that representation is independent of perceptual input, embodied cognition theory grounds representation in perception and action (Barsalou, 1999; Glenberg, 2000; Thelen & Smith, 1994; van Gelder & Port, 1995).

Specifically, representation is hypothesized to involve the internally generated *re-presentation* of perceptual experience (Barsalou, 1999). That is, the mental structures involved in perception are not just used for passively recording sensation but also can be used productively to *simulate* or r*e-present* perceptual sensation. Thus, perceptual systems serve a dual function to record and interpret sensation and. to re-create or re-present this sensation through simulation. Representation, therefore, involves a simulated perceptual experience. For example, if you were to imagine an absent toy car, you would generate a simulated perceptual experience that is normally associated with the external perceptual input of the toy car. Visual perceptual systems would fire as if the shape, the color of the toy car were present in the immediate environment. Motor perceptual systems would fire as if you were moving the toy car back and forth. There is empirical support for these proposals as neuroscience research has shown that these processes of re-presentation or perceptual simulation occur in adult visual and motor imagery (Kosslyn & Thompson, 2003; Decety, 2002.)

Furthermore, because representation involves re-presentation of perceptual experience, what you directly perceive can also support perceptual simulation. What you see, hear, touch smell, and taste, could support the thought you hold in mind. When external perceptual input is congruent with internal re-presentations, it takes less cognitive work to simulate the missing perceptual *stimulation* (Barsalou, 1999). If you were exposed to the smell of a freshly mown lawn, it would be less difficult to represent "grass" because it requires the re-presentation or simulation of its smell. To return to the earlier example, if you were to imagine an absent toy car and within your visual field is a rectangular block, made of a solid, hard material that matched the color of the imagined car, you would not have to engage in the cognitive work to visually simulate shape, solidity or color. If you were allowed to pick up said block and move it laterally on a table you would not have to engage in the motor simulation of the movements normally associated with playing with a toy car. Therefore, directly perceiving these elements of a toy car saves you the work of having to re-present them.

Moreover, and most importantly for explaining children's performance across pretense comprehension tasks, simply moving with a block in this way may also trigger your perceptual simulation of a car. Action and motor perceptual input guide representation (Ganis, Keenan, Kosslyn & Pascual-Leone, 2000, Markman & Dietrich, 2000). You might pick up a block and move it laterally back and forth across the floor with no intention of simulating an absent toy car. However, the familiarity of this lateral, back and forth movement and its motoric association with playing with a toy car leads you to simulate or re-present a toy car. Therefore, action, instead of merely being the consequence of re-presentation, can be a crucial factor in eliciting or generating re-presentation.

In summary, re-conceptualizing representation as a process perceptual simulation or re-presentation challenges the traditional view of representation found in current theories of pretend play. Namely, it challenges assumptions that pretense representation occurs independently of perceptual input and that action is optional for pretense representation. Because representation is re-conceptualized as perceptual simulation, direct perceptual input, both motor and visual, could facilitate pretense representation. Moreover, action and its corresponding motor perception could guide pretense representation.

1.3 EMBODIED PRETEND PLAY

Pretend play representation, therefore, could be re-conceptualized as an embodied process of perceptual simulation. To participate in pretense, such as pretending a block is a toy car, a child must both override and use elements of his perceived physical world. Pretense would require that a child's simulated perceptual re-presentation of the car penetrates or takes precedence over his or her perceptual experience of the block. A child not only internally simulates an absent toy car but he may also uses this simulated perceptual experience of the toy car to override some elements of the externally generated perceptual experience of the present block such as the absence of wheels, bumpers, doors, and other elements of a car. Meanwhile, other perceptual elements of the block congruent with the re-presentation of a toy car such as its general rectangular shape, its solidity and lateral placement to the floor could support his perceptual simulation of the toy car.

In order to be pretend play, this re-presentation of a car must also be projected onto the block intentionally. A child would not be pretending if he simply saw a block and thought of a car (Lillard, 2001). Furthermore, if a child saw a block and mistook it for a car unintentionally, he would be hallucinating rather than pretending (Lillard, 2001; Perner, 1991). Thus, the child simulates the perceptual experience necessary for re-presenting the car and intentionally projects this on to his immediate perceptual experience of the actual block.

However, this does not mean necessarily that pretense representation precedes children's actions. A child does not necessarily have to move the block with the intention of re-presenting a car and then projecting it on to the block. The child's movement with the car and the corresponding motor perceptual input could precede or trigger the off-line simulation/pretense re-presentation of the absent car. If a child moves the block around the floor without intending to represent the absent car, this movement might activate a simulation of the absent car, which he then intentionally projects on to the block. Action with the block and the corresponding direct motor perceptual input could initially bootstrap and later sustain his re-presentation of the absent toy car.

To return to the earlier question, "Could children's actions with toys and corresponding direct motor perceptual input support their pretense representations?" Embodied cognition theories would answer with a resounding "Yes." Thus, re-conceptualizing pretense representation as embodied perceptual simulation and proposing that action could guide pretense representation may help explain the patterns of performance that toddlers and preschoolers display across pretense comprehension tasks.

1.4 EMBODIED PRETEND PLAY DEVELOPMENT

The goal of the current paper is to propose that an embodied re-conceptualization of pretense representation can explain the developmental trends we see in toddlers' performance on tasks of pretense comprehension. When toddlers appear to understand pretense and when they don't could reflect their early dependence on motor perceptual input to initiate and sustain pretend play re-presentation. However, as toddlers become more skilled at motor perceptual simulation, they might rely less and less on motor perceptual input. Thus, toddlers' growing ability to simulate perceptual experience is hypothesized to drive observable changes in pretense comprehension across development.

The current paper will focus on describing the very first shifts in children's capacity for pretense re-presentation, between one and a half months and two and a half years of age in terms of motor perceptual input, both direct and indirect.

1.4.1 Imitation and direct motor perceptual input

Around 18 to 20 months of age, toddlers first engage in simple pretend play actions (Fein, 1981). A young toddler might bring an empty cup to his lips to "drink" absent, pretend liquid or attempt to "eat" a plastic strawberry. Contrary to earlier views of pretend play as a primarily solitary activity (Piaget, 1965), the majority of recent research on pretend play development has demonstrated that children's earliest engagement in pretense is primarily imitative and socially mediated (Rakoczy, Tomasello & Striano, 2006).

When toddlers first begin to pretend, imitation may provide the richest motor input because it provides children with a visual display of the model's actions, a precise path of motion and, perhaps most importantly, the motivation to move with replica and substitute toys. This motion and its direct motor perceptual input may guide pretense re-presentation. Although pretend actions could begin as blind mimicry of another's actions, direct motor perceptual input might elicit 18-20 month olds' pretense re-presentation and help them project this re-presentation on to the pretend play toy. For example, when toddlers imitate an adult pushing a block laterally on the floor, they have a model for the exact path of motion and receive rich direct motor perceptual input from their movements which in turn could elicit their re-presentation of the absent toy car. Imitation, therefore, may be an important social mechanism for early pretense by providing young toddlers with robust and direct motor perceptual means to elicit and sustain their earliest off-line perceptual simulations.

However, if young toddlers (18-20 months) simply observe another's pretense action without acting with the toy themselves, their pretense re-presentation receives no direct support from their own motor perceptual input. Because toddlers have no opportunity to move with the toy, they may have to be more skilled at autonomous motor perceptual simulation to represent the absent object to which the toy refers. For example, when young toddlers merely observe an adult pushing the block laterally across the floor, they might need to simulate the experimenter's action in order to represent the toy car. Young toddlers perhaps do not have this capability and thus, their comprehension of others' pretense actions and corresponding capacity for pretend representation might appear diminished or even non-existent (Harris & Kavanaugh, 1993; Rakoczy & Tomasello, 2006; Tomasello et al., 1999).

1.4.2 Action observation and indirect motor perceptual input

By 26-28 months of age, though, young children demonstrate comprehension of pretense when simply observing another's pretense action without acting with the toy themselves. Children at this age are able to imitate incomplete pretend play actions (Rakoczy & Tomasello, 2006), match pretense toys to others' pretend play actions (Tomasello et al., 1999) and follow verbal directions to extend others' pretense actions (Harris & Kavanaugh, 1993; Walker-Andrews, 1999). Older toddlers (26-28 months) may no longer need the rich direct motor perceptual input that imitation provides and may be capable of the motor simulation needed for pretense re-presentation just from watching another's actions. Therefore, by 26-28 months, toddlers might be able to simply watch an adults actions with a block and re-present the absent toy car. Thus, they would comprehend the adults' actions with little direct motor perceptual input.

However, observing an adults' action may still provide some indirect motor perceptual input. Watching another's pretend play action may provide 26-28 month old toddlers with a visual cue to activate their own internal motor simulation of the action, which, in turn, supports their pretense re-presentation. For example, when a toddler watches an adult push a block, it might serve as an indirect cue to activate their own internal simulation of that motion. Thus, when a toddler observes another's pretense action, it could serve as an indirect visual reminder of which action they need to simulate in order to engage in pretense re-presentation. Simply watching another's pretense action may provide indirect motor perceptual input. The term indirect motor perceptual input will be used throughout the thesis to describe this event.

However, without indirect motor perceptual support, 26 to 28 month olds also have difficulty engaging in pretense re-presentation. If toddlers watch another's action with a pretense toy and are then asked to match this pretense toy to a static display such as the corresponding referent object, they appear incapable of matching these static objects until 35 months of age (Tomasello et al., 1999.). For example, if a toddler watches an experimenter push a block and is then asked to choose from a series of static objects which object the block refers to, only by 35 months of age will he pick the correct referent, a toy car (Tomasello et al., 1999). In this case, toddlers may have had to independently generate motor perceptual simulation. In order to see a block and re-present the absent toy car they have to re-present the actions with the block on their own, with no indirect motor perceptual cue. Thus, engaging in a pretend comprehension task would be considerably more difficult without any indirect motor support, ie. without watching another person engage in the action .

Therefore, children's performance on tasks of pretense comprehension is hypothesized to reflect a progression from their need for a combination of direct and indirect motor perceptual input at 18-20 months of age, to indirect motor perceptual input at 26-28 months of age and perhaps even independence from any motor perceptual input by 3-4 years of age.

1.4.3 Interactions between motor and visual perceptual support

Motor perceptual input is likely not the sole perceptual factor that assists pretense re-presentation. The motor perceptual input children receive also probably interacts interact with the visual perceptual support they receive from the visual qualities of the toy such as its shape, solidity, color or size. Just like motor perceptual input, visual perceptual input could support the representation of absent pretend referents by reducing cognitive load of re-presentation. For example, when 18-month-olds “sip” from replica spoon, the visual perceptual input from a replica spoon could support toddlers’ off-line perceptual simulation of an actual spoon and absent liquid. Because pretense simulation is so cognitively demanding, children’s earliest pretend play may also be particularly dependent on the visual similarity between the pretend toy and the absent referent in addition to motor perceptual input. However, as toddlers become more proficient in pretense, they can use toys that are progressively more visually distanced from their referents, a process described as “decontextualization” (Belsky & Most, 1981; Elder& Pederson, 1978; Fenson, 1984; Fenson & Ramsey, 1980; Jackowitz & Watson, 1980; Piaget ,1965; Ungerer et al., 1981).

By 20 months toddlers can use substitute toys such as a stick as a spoon (Fenson, 1984; Ungerer et al., 1981; Jackowitz & Watson, 1980.). Because the stick looks considerably different from its referent “spoon,” representing the absent object requires considerably more cognitive work. Decontextualization, therefore, could be a result of toddlers becoming more competent at the visual perceptual simulation necessary for pretense re-presentation (Elder, Zelazo, Kearsly, & O’Leary, 1981; Fein, 1981; Piaget, 1945; Striano et al., 2001).

Thus, toddlers are hypothesized to demonstrate earliest comprehension of pretense when they receive motor input that supports their pretense simulation and when they engage in actions with pretend toys that are visually similar to their referents. However, as children become more skilled at motor and visual perceptual simulation, they are expected to rely less on direct motor and visual input to support their re-presentation of absent objects. The changing roles of motor and visual perceptual input for pretense representation, therefore, could explain developmental trends in children’s performance across pretend play comprehension tasks.

1.5 THE CURRENT STUDY

The overarching goal of the current study was to test whether motor perceptual input could facilitate toddlers' pretend play representations and explain variability in children's apparent pretense comprehension. Toddlers at an average age of 20 months and 28 months were tested because previous studies have suggested that these ages represent the earliest developmental shift in children's abilities to comprehend pretense.

Imitation is frequently used as a principal measure of toddlers' understanding of social cognitive concepts including intention and desire understanding (for a review see Want & Harris, 2002). However, because one of the purposes of the current study was to experimentally manipulate children's direct motor perceptual input and action with pretend play toys, imitation needed to be used as a means to engage children in action rather than as a measure of understanding. Thus, a task was needed that used a non-imitative measure of toddlers' pretend play comprehension.

To that end, a matching paradigm developed by Tomasello, Striano & Rochat (1999) was adapted. In the original study, children observed an experimenter engage in actions with four pretense toys and pretense comprehension was measured by children's ability to match these pretense toys to referent objects or to the experimenter's pantomimed action. Adapting this matching paradigm had three advantages: First, because imitation was not used as the principal measure of pretense understanding, I could experimentally manipulate toddlers' direct motor perceptual input by manipulating whether or not toddlers imitated the experimenter's actions with the toys before being asked to match toys to their referents. Some children were given the opportunity to imitate (direct motor perceptual input) and others were not (no direct motor perceptual input). Second, it allowed me to experimentally manipulate toddlers' indirect motor perceptual input by manipulating whether toddlers matched pretense toys to the experimenter's pantomimed actions (indirect motor perceptual input) or to static referent objects (no indirect motor input). Third, because the matching task could be used with both replica and substitute toys, it also permitted examination of a possible interaction between motor and visual perceptual input.

However, use of the paradigm had a singular disadvantages. Toddlers' performance on the task could also possibly be explained by a simple lower-level mechanism. One possibility is that toddlers could match toys to the experimenter's actions simply because they learned an association between the toy and action through participating in the task. They may not have needed to engage in pretense re-presentation at all to be able to match pretense toys to the experimenters' actions. They would only have to know that this toy and that action go together.

Therefore, a set of unfamiliar non-pretense toys and actions which did not require pretense re-presentation was also introduced. These control toys allowed us to assess whether toddlers' were capable of learning a simple association between object and action during participation for the task and then to control for this skill when assessing their ability to match pretense objects to the experimenter's pantomimed actions.

Thus, an adaptation of the pretense comprehension matching paradigm was used in which children's opportunities for imitation (direct motor input), their observation to the experimenter's action (indirect motor input), and the similarity between the pretense toy and its object referent were manipulated (visual input). In addition, the matching procedure was repeated with unfamiliar non-pretense objects to assure that children's performance on the task could not be explained by simple association learning.

1.6 HYPOTHESES

Most generally, motor perceptual input was hypothesized to drive pretense re-presentation among young children whose ability to engage in such play is just emerging.

Five main hypotheses were tested:

First, motor input was hypothesized to be important to facilitate children's pretense understanding.

Children were expected select the correct toy more often when given the chance to receive direct motor input from imitating with the toys. Because direct motor perceptual input was conceptualized to drive pretense re-presentation, it was expected that toddlers would match the correct toy more often when given the opportunity to imitate (direct motor perceptual input). Children were also expected select the correct toy more often when given the chance to receive indirect motor input from watching the experimenter pantomime an action with the toys. It was expected that toddlers would match the correct toy more often requested to select the correct toy by watching the experimenter's pantomimed action (indirect motor perceptual support).

Direct motor input from imitating and indirect motor input from observing the experimenter's action were hypothesized to interact and work synergistically to support pretense representation. Toddlers were hypothesized to do best on the task they imitated the experimenter and were asked to match the pretense toy to the experimenter's pantomimed action.

Second, visual perceptual input was also hypothesized to be important for children's pretense understanding. Because, replica toys are more visually similar to their referents, it was hypothesized that there would be a main effect for toy such that replica toys would be easier to match to their referents than substitute toys when all other factors were equal.

However, motor input was hypothesized to interact with visual input to affect comprehension of the task. It was expected that if no direct motor input (from imitating the experimenter's action) or indirect motor input (from observing the experimenter's pantomimed action) was present then children would show better performance with the replica toys. However, it was also expected if direct motor input (from imitating the experimenter's action) and indirect motor input (from observing the experimenter's action) was present, then children would show equal performance with the substitute toys as the replica toys. In other words, the benefit of having more visually similar toys would be washed out if more motor perceptual input was present.

Third, children were expected to do better on the task as they got older and were expected to need less direct and indirect motor perceptual input and less visual perceptual input to comprehend the task.

Younger toddlers (20 months) were hypothesized to need the most motor perceptual support to engage in pretense representation because their pretend representation skills are just emerging. Thus, they were hypothesized to need both direct and indirect motor perceptual cues to engage in pretense re-presentation, more so than older toddlers. Younger children were hypothesized to match the correct toy more often when they imitated the experimenter and matched a toy to the experimenter's pantomimed action.

Older children (28 months) were expected to need less direct motor perceptual support (from imitation) than younger toddlers and need only indirect motor perceptual input (from watching the experimenter's action) to engage in pretense re-presentation. Because older toddlers' have demonstrated comprehension of pretense in other studies when they only observe an experimenter's action (Rakoczy & Tomasello, 2006), they were expected to have a more robust capacity for pretend representation and expected to match the correct toy to the experimenter’s action even when they had not imitated the experimenter.

Fourth, because imitation is conceptualized to provide rich direct motor perceptual input, the fidelity and frequency of toddler’s imitation with toys was also expected to predict their ability to match toys to referent objects or actions. Toddlers were hypothesized to select the correct object more often if they engaged in more faithful and more frequent imitation of the experimenter’s model.

Fifth, finally, children’s ability to match a pretense toy with an action was hypothesized to be unrelated their ability to learn a simple association between the pretense toy and action over the course of the task. In particular, children were not expected to be able to match the correct control toy to the experimenter’s action and thus, children’s performance on the pretend matching task was not expected to be due simply to associative learning.

2.0 METHODS

2.1 PARTICIPANTS

Approximately 122 toddlers (64 boys) were recruited from 6 childcare centers or phone lists of toddlers in the Pittsburgh, PA metropolitan area. Two age groups were recruited: 19-21 months (*N* = 47; 26 boys; M= 20.23 months) and 27-29 months (N= 47; 25 boys, M=28.49 months). These ages were chosen because toddlers at these ages demonstrate the most variability in their performance in tasks of replica and object substitution pretense suggesting that it is a developmental transition period (Watson & Fischer, 1977; Harris & Kavanaugh, 1993; Tomasello et al., 1999). All children or their classrooms received a small gift for participation in the study.

Families were from a medium-sized urban area and varied from working class to upper middle class by parent report; 2% were African-American, 4% Asian , 90% Caucasian, and 4% Latino. All children had playgroup or child-care experience. Thirty-two recruited participants could not be used for the following reasons: They did not pass training (20 month olds, N = 9; 28 month olds, N=1); They stopped in the middle of the task (20 month olds, N=1; 28 month olds N = 4); They were afraid of the apparatus used in the experiment (20 month olds, N=3); They refused to imitate the experimenter (20 month olds N=1; 28 month olds N=4). In addition, some children's data was unusable because of video equipment failure or experimenter error (20 month olds N = 4; 29 month olds N=1).   Four children (28 months) were also excluded because teachers reported a suspicion of developmental delay.

2.2 APPARATUS

All children engaged in a pretense matching task adapted from a task used by Tomasello et al. (1999) to study pretense comprehension. The apparatus for this experiment was significantly modified. Tomasello et al. (1999) reported significant difficulty in training younger toddlers to match objects by sliding them down a chute, a full fifty percent (9/18) failed to pass training (Tomasello et al., 1999). The “chute” was transformed to “Wormy” a friendly Elmo™-like worm creature made out of an upholstered vent hose (see figure 1) mounted up on an upholsteredwooden base. Wormy stood 19 inches tall and was 4 inches in diameter.[1]

Figure 1. Wormy and Experimenter

[1] Special thanks to Jenny Ganger for being the inventor of a similar apparatus and suggesting that “Wormy” might be useful in this task

I believed that “feeding” a character would be more motivating for younger children than merely sliding an object to the experimenter down a chute. Because Wormy had a dark mouth which most children found minimally intimidating, I also believed that the task would inhibit younger children’s impulse to put multiple objects in Wormy’s mouth, a problem Tomasello et al. reported in their original “chute” study. Also I hoped that “feeding Wormy” pulled for more pretend play from younger toddlers because they were engaging in a fantastical, pretend-like task rather than sliding an object down a chute.

A child sat on a child-size mat across from Wormy and the experimenter. When Wormy was “fed” toys, the toys entered his mouth, slid down, and rested at the end of the worm, where the experimenter could retrieve them. All procedures were videotaped for later coding. A camera on a tripod was operated by an assistant experimenter and was placed above and behind the experimenter so that the child’s actions and choice of objects could be easily recorded. The assistant experimenter looked through the viewfinder of the camera and did not interact with the children or respond to the children’s actions in any way during the task.

2.3 OVERVIEW

The child was introduced to the task by the experimenter stating, “This is Wormy and wormy likes to eat toys. I’m going to show you which toys Wormy likes to eat.”

The task consisted of two phases: 1) a demonstration phase and 2) a request phase. In the *demonstration* phase, toddlers observed the experimenter engage in pretense behaviors with a set of four toys. There were two demonstration conditions manipulated between subjects: 1) An **imitation** condition in which the child imitated each of the experimenter’s actions 4 immediately after watching the experimenter perform the action or 2) An **observation** condition (indirect motor perceptual input) in which the child simply watched the experimenter engage in the 4 pretense actions.

During the *request* phase of the task, the experimenter placed the four pretend toys within the child's reach and requested that the child "feed" each of the four toys to Wormy by stating "Wormy wants to eat this one." The request was made in one of two different ways manipulated between subjects: 1) An **object request** condition (visual perceptual input) in which the experimenter showed the child the referent object to which the pretend toy referred. For example if the experimenter previously had demonstrated "brushing" her teeth with a stick, she requested that the child "feed" Wormy the stick by showing the child an actual toothbrush. 2) An **action request** (motor perceptual input) condition in which the experimenter pantomimed the previously demonstrated pretend action without the pretend toy. For example, to request the stick the experimenter pantomimed brushing her teeth without the stick.

The 2 request conditions were crossed with the 2 demonstration conditions to create 4 groups at each age: 1) Children who had received the observation demonstration and object request conditions, 2) Children who had received the observation demonstration and action request conditions 3) Children who had received the imitation demonstration and object request conditions and 4) Children who had received the imitation demonstration and action request conditions (see table 1).

Table 1. Study Design

		Request Condition	
		Object	*Action*
Demonstration Condition	*Observation*	**Observation-Object** (20 mos. n=12; 28 mos. n=13)	**Observation-Action** (20 mos. n=11, 28 mos. n=11)
	Imitation	**Imitation-Object** (20 mos. n=12; 28 mos. n=12)	**Imitation-Action** (20 mos. n=12, 28 mos., n=11)

These procedures were conducted with two sets of pretense *toys:* 1) **replica** and 2) **substitute toys**, manipulated within subjects and counterbalanced for order. All objects were familiar to children of this age.

Finally, children in the action request condition also received a third set of unfamiliar toys always presented last as a control condition 3) **control toys**. These control toys were novel and each was paired with an unfamiliar non-pretense action. Control toys were meant to ensure that children in the action request condition were not merely learning a simple association between toy and action during the task. The inclusion of a third set of novel unfamiliar toys and actions allowed us to control for this lower-level explanation of children's ability to match pretense toys to actions.

The entire visit was videotaped and testing procedures lasted approximately 10-15 minutes.

2.4 MATERIALS

The toys used were modified from the original Tomasello et al. (1999) study. Because descriptive studies of pretend play development have repeatedly shown that toddlers first engage in pretend actions towards the self before pretend actions towards others (decentration, Watson & Fisher, 1977), all pretense actions were self-directed.   Therefore, the only toys carried over from Tomasello et al., (1999) were toys which afforded self-directed action. The following toys were used:

2.4.1 Training Toys

A toy car, yellow plastic duck, a doll, and a plastic bear were used. All of the toys are familiar to children of this age range and easily identifiable (see figure 2).

Figure 2. Training Toys

2.4.2 Replica toys and referent objects

A pink toy replica bottle and corresponding real purple bottle; a yellow toy replica phone receiver and a beige real phone receiver; a white toy replica hairbrush and a real brown wooden hairbrush; and a black toy replica baseball hat and a real blue baseball cap were used (see figure 3).

Figure 3. Replica Toys and Referent Objects

2.4.3 Substitute toys and referent objects

A cardboard box (used as a shoe) and a real shoe, a blue ball (used as an apple) and a real apple; a wooden block (used as a washcloth), and a real white washcloth and a green stick (used as a toothbrush), and a real white toothbrush were used (see figure 4).

Figure 4. Substitute Toys and Referent Objects

The replica and substitute toys were all visually similar to their referent objects in shape but different in color to ensure that children were not simply matching on the basis of color.

2.4.4 Control toys

Finally, children who participated in the action request condition also received a third set of unfamiliar control toys: a turkey baster top, green plastic ring, a white pvc pipe adaptor, and a small orange horseshoe-shaped plastic ring (see figure 5).

Figure 5. Control Toys

2.5 TESTING PROCEDURE

All testing took place in the laboratory, in children's homes, or in childcare center classrooms within a medium sized city. When tested in the laboratory or at home, the children's mothers were present but were instructed not to interfere with the testing or to explicitly direct their children's response. When children were tested at their childcare center, they were tested in quiet hallways away from the distraction of their classrooms.

2.5.1 Warm-up Play

Children tested in the laboratory or their homes were given 10 minutes of warm-up play with the experimenter and assistant experimenter and a standard set of toys: a doll, tools, a cooking set, and a doll-sized bed and bathtub. A warm-up period was used ensure that the children felt comfortable in the unfamiliar laboratory setting or in the case of children tested at home that they felt comfortable with the unfamiliar experimenters. For all children tested in their childcare classrooms, the experimenter and assistant experimenter spent approximately 20-30 minutes playing with the child and his or her peers in the classroom before beginning the task.

2.5.2 Training Task

The experimenter introduced the child to Wormy by stating "This is my friend Wormy and he likes to eat toys. Do you want to see which toys he likes to eat?" The experimenter would demonstrated that each of the four objects, a duck, bear, toy car, and small plastic doll could slide down Wormy by pretending that Wormy was talking to her, "What's that Wormy, you want to eat the car?" and then the "feeding" Wormy the car. The experimenter then placed the four toys in front of the child next to Wormy on the floor (see Figure 1). She then instructed the toddler which object to slide down the chute by stating "Now it's your turn, Wormy wants to eat the…." and verbally requesting each one, i.e. "ducky", "car", "girl," and "bear." Children were considered ready for testing if they could send three objects correctly in a row without assistance. If children needed additional prompting the experimenter would point and sweep across the four objects stating, for example, "Which one of these is the….car?" The training task was repeated until the child met this criterion.

2.5.3 Pretense Comprehension Task.

As briefly mentioned, the task consisted of two phases, a demonstration phase and a request phase.

2.5.3.1 Demonstration phase.

During the demonstration phase, each child watched the experimenter interact with a set of four toys. Pretend play actions with each of the four toys were demonstrated individually. Each action was demonstrated three times. In the **observation condition**, children were asked "Are you ready to play a pretend game with me? Let's pretend. Watch me, it's my turn" and simply watched as the experimenter demonstrated each action with each toy. The four toys were then placed on the floor between the experimenter and the child.

In the **imitation condition**, the children were asked "Are you ready to play a pretend game with me? Let's pretend. Watch me, it's my turn" and then given each toy individually immediately after the demonstration and told "Now it's your turn." If children refused to imitate the experimenter encouraged them by saying “Now you try, go ahead, it’s your turn.” After the child had imitated the experimenter the toy was retrieved and the next toy was demonstrated and imitated. When all four actions had been demonstrated to and imitated by the child, the toys were placed on the floor between the experimenter and child.

In both conditions, the presentation order of the toys and the placement of the toys was were counterbalanced. The experimenter smiled and looked at the children during and after the demonstration of each four toys, using body language commonly used in pretense to communicate “this is pretend.” (Lillard & Witherington, 2004; Richert & Lillard, 2004).

2.5.3.2 Request phase.

During the request phase, after the four toys had been placed on the floor and were now within the child’s reach, the experimenter told the child “Wormy is hungry he wants to eat these toys. Wormy wants to eat this one. Can you feed him this one” without naming the toy. This request was made either by showing the child the object to which the toy referred (**object request condition**) or by pantomiming the action (**action request condition**) previously demonstrated with the toy (details to follow).

If the child failed to respond, the experimenter asked the child two more times. If the child failed to respond within 60 seconds or the child sled more than one toy to Wormy, the request was repeated. If children needed additional prompting the experimenter would sweep a pointed index finger across the toys and state, “Which one of these is this one. Can you give it to Wormy? Could you put it in his mouth?” After the child made his or her choice, placed the toy in Wormy’s mouth and the toy had traveled down the tube, it was replaced on the floor to ensure that the child always chose from four toys. The toys were requested in the same order as they had been demonstrated

As briefly mentioned, the request phase had two conditions. In the **object request condition**, the experimenter requested each of the four toys by showing the child each toy's referent object one at a time while stating "Wormy wants to eat this one. Can you feed him this one?" In the **action request condition**, the experimenter requested each toy by pantomiming each of the four actions previously demonstrated with the toy while stating "Wormy wants to eat this one. Can you feed him this one?" If the child did not attend to the examiner during either condition, a small clicker was used to draw the child's gaze to the referent object or action.

The demonstration and request phases of the chute task were conducted twice with each child, once with replica toys, and once with substitute toys and with each child the order of presentation was counterbalanced.

2.5.3.3 Replica toys.

During the *demonstration* phase with the replica toys, the experimenter first introduced the toddler to the four target replica toys (the toy bottle, toy brush, toy phone and toy hat) and individually demonstrating a pretend action with each toy. Each pretend action was accompanied by verbalizations which suggested the replica toy's referent object but no object labels were used. For the bottle, the experimenter made slurping noises as she "drank" from the bottle. With the brush, the experimenter said, "Oh, my hair is messy" as she ran the brush over her head. Holding the phone to her ear, she said "Hello, hello." Putting the hat on she said, "I'm getting ready to go outside." Children in the **observation condition** simply watched these actions whereas children in the **imitation condition** were given the replica toy after each demonstration and encouraged to imitate the experimenters' actions with the toys.

Following the demonstration phase, all children were asked to choose specific toys to feed to Wormy in the request phase. The four replica toys that had been used in the preceding demonstration phase were set out in front of the child and the experimenter gave a specific request to the child to choose one to feed to Wormy. The r*equest phase* with the replica toys had two request conditions, object and action request. In the **object request condition**, the experimenter requested the replica toy by holding up the referent object for each replica toy (ie. an actual bottle, brush, phone receiver and hat) each one at a time. For example, when requesting the toy baby bottle, the experimenter showed the child the real baby bottle while saying as a cue, “Wormy wants to eat this one.” In the **action request condition**, the experimenter pantomimed the previously demonstrated actions to request that the object be fed to Wormy. For example, to request the toy baby bottle, she made the same drinking movement by “holding” an imaginary bottle and bringing it to her lips that she had previously demonstrated. In this case, however, she was not holding the toy and only used the action as a cue.

2.5.3.4 Substitute toys.

During the *demonstration phase* with substitute toys, the experimenter first introduced the toddler to the four substitute toys (a box, a block, a ball, and a stick) and individually demonstrated a pretend action with each toy. Each pretend action was also accompanied by verbalizations which suggested the substitute toy’s referent object but no object labels were used. Specifically, the experimenter placed the box on her foot and stated “I better put these on to go outside.” The experimenter took a pretend bite from the ball and made exaggerated chewing and munching noises. The block was rubbed on the experimenter’s arms as she said, “I’m going to get clean” and the stick was used to imitate a tooth brushing action as she made brushing sounds. Children in the **observation condition** simply watched these actions whereas children in the **imitation condition** were given the substitute toy after each demonstration and encouraged to imitate the experimenters’ actions with the toys.

Following the demonstration phase, all children were asked to choose specific toys to feed to Wormy in the request phase. The four replica toys that had been used in the preceding demonstration phase were set out in front of the child who was now to choose the correct one to feed to Wormy based on the experimenters' specific request. During this *request phase*, the experimenter requested each substitute toy in the child's possession by either showing the substitute toy's referent object (object request condition) or pantomiming the action shown with the substitute toy (action request condition). In the **object request condition** the experimenter requested the substitute toy while holding up the referent object for the substitute toy (i.e. a shoe, washcloth, apple, and toothbrush). For example, when requesting the box toy, the experimenter showed the child the real shoe while saying as a cue, "Wormy wants to eat this one." In the **action request condition**, in contrast, the experimenter requested the substitute toy by pantomiming the action while stating "Wormy wants to eat this one." For example to request the box toy, she made the same putting on a shoe movement by bringing her hand to her foot that she had previously demonstrated. In this case, however, she was not holding the toy only using the action as a cue.

2.5.3.5 Control toys.

Children in the action request condition in both the observation and imitation demonstration conditions were also shown a third set of unfamiliar control toys, always presented last (a grey turkey baster top, a green plastic ring, a pvc pipe adapter, and an orange plastic horseshoe). During the demonstration phase with the control toys, the experimenter first introduced the toddler to the four control toys by stating "Watch me," and demonstrating an action with each one while stating "I'm doing this." With the turkey baster top, the experimenter squeezed the bulb and placed the opening on the palm of her hand making a sucking noise with the bulb.   For the green plastic ring, the experimenter placed the ring with her right hand over her left fingers with an exaggerated motion. The pvc pipe adapter was lightly twisted on the experimenter's arm, and the small orange plastic horseshoe was brought up to the bridge of the experimenter's nose. In the observation condition, children simply watched these actions whereas in the imitation condition they were given each control toy after each demonstration and encouraged to imitate the experimenter's actions with the toys.

During the subsequent request phase, only the action request was used. The experimenter requested the control toys stating, "Wormy wants to eat this one" while pantomiming the actions previously used with each of the control toys.

Like the pretend toy sets, all of the control toys afforded self-directed actions. Use of this toy set was meant to determine whether children were merely learning a simple association between action and toy during the task and then using this association when matching replica and substitute toys to the pantomimed action in the pretend toys conditions.

2.6 CODING PROCEDURES

Children's performance was rated from the videotape. An independent coder blind to the study hypotheses coded the videotapes. Interrater reliability (kappa) with the first author was assessed on 10% of the final collected data. In keeping with Tomasello et al.'s (1999) original protocol, children's selection of toy was coded as correct if they "fed" the matching toy to Wormy. If the toddler chose not to touch any toys within 60 seconds of the last request for a toy, the trial was scored as incorrect. If the toddler fed two toys to Wormy and the trial was repeated, only the toddler's performance on the repeated trial was scored. Cohen's kappa for percentage correct toy choice was .78 for the replica toy set, .84 for the substitute toy set and .75 for the control toy set. The score used in analyses was the percentage of correct toys selected out of four trials (*percentage correct toy choice*).

In the imitation condition of the chute task, toddlers' performance was additionally rated for each toy on a 0-3 scale where 0 is no imitation, 1 is an imitation attempt without similarity to the model, 2 is imitation that approximates the model, and 3 is imitation identical to the experimenter's actions (kappa = .75). These imitation ratings were averaged across toys to create the variable *average* imitation fidelity which was calculated separately *for* the replica, substitute and control toys. The total frequency of imitation was also coded separately to create the variables *total imitation frequency* (percent agreement = .87) and *percentage of toys imitated* (kappa = .90) for the replica, substitute and control toys

3.0 RESULTS

3.1 DESCRIPTIVE ANALYSES

Means and standard deviations for 20 and 28 month olds' percentage correct toy choice in each condition are presented in Table 2. Average performance ranged between 25.00% to 61.36% correct toy choice depending on their age and condition. Percentages are frequently normalized by arcsine tranformations if they are outside the range 30% - 70% and are non-normally distributed. Shapiro-Wilks tests of normality demonstrated that both percentage correct toy choice for replica and substitute toys were normally distributed, Shapiro-Wilks (97) = .90, $p<.001$, and Shapiro-Wilks (97) = .89, $p<.001$. Thus, the variables were not transformed for substantive analyses.

Table 2. Percentage correct toy choice in each condition, toy type, and age.

	Request Conditions			
	Object Request		*Action Request*	
Demonstration Conditions	20 month olds Mean (SD)	28 month olds Mean (SD)	20 month olds Mean (SD)	28 month olds Mean (SD)
Observation				
Replica Toys	50.00 (25.00)	57.69 (29.55)	25.00(16.67)	47.73 (32.51)
Substitute Toys	25.00 (25.00)	36.54 (26.25)	37.50 (24.29)	40.91 (28.00)
Control Toys	---	---	42.50 (57.95)	54.55 (31.26)
Imitation				
Replica Toys	48.08 (35.09)	54.17 (35.09)	42.31 (21.37)	59.09 (23.11)
Substitute Toys	26.92 (12.87)	31.25 (28.45)	42.31 (18.77)	61.36 (23.35)
Control Toys	----	----	30.56 (24.30)	45.45 (24.54)

[1.] Possible scores ranged from 0-100% correct toy choice.

Means and standard deviations for 20 and 28 month old toddlers' imitation variables are presented in Tables 3 and 4, respectively. These means show that on average the imitation manipulation during the demonstration phase of the task was successful. Children in the observation conditions rarely imitated the experimenter (Means for imitation frequency ranged from 0 to .73 and means for percentage of toys imitated ranged from 0% to 11.36 %). In contrast, children in the imitation condition imitated the experimenter 4.25 to 4.36 times with 88.64% to 100% of the toys.

Table 3. Means and Standard Deviations for Imitation Frequency, Average Fidelity of Imitation and Percentage of Toys (of4) that Children Imitated at 20 months of age

	Request Conditions			
	Object		Action	
Demonstration Conditions	Observation Mean (SD)	Imitation Mean (SD)	Observation Mean (SD)	Imitation Mean (SD)
Replica Toys				
Imitation Frequency	0(0)	4.33(.98)	.10(.32)	4.27(1.84)
Average Imitation Fidelity	0(0)	2.06(.26)	.05(.16)	2.02(.69)
Percentage of Toys Imitated	0(0)	95.83(9.73)	2.50(7.90)	90.91(.30)
Substitute Toys				
Imitation Frequency	0(0)	4.33(.78)	.20(.63)	4.6(2.06)
Average Imitation Fidelity	0(0)	1.95(.23)	.08(.24)	1.84(.32)
Percentage of Toys Imitated	0(0)	97.92(7.21)	5.00(.16)	88.64(30.33)
Control Toys				
Imitation Frequency	---	----	0(0)	5.11(2.89)
Average Imitation Fidelity	---	----	0(0)	1.75(.67)
Percentage of Toys Imitated	---	----	0(0)	88.89(33.33)

Possible scores for:

[1.] Imitation Frequency ranged from 0-1 in the observation conditions and from 3-12 in the imitation condition.

[2.] Average Imitation Quality ranged from 0 (no imitation of the experimenter) to 3 (identical duplication of the experimenter's actions)

[3.] Percentage of Toys Imitated ranged from 0 in the observation condition to 88.89% in the imitation condition

Table 4. Means and Standard Deviations for Imitation Frequency, Average Fidelity of Imitation and Percentage of Toys(of 4) that Children Imitated at 28 months of age.

	Request Conditions			
	Object		Action	
Demonstration Conditions	Observation Mean (SD)	Imitation Mean (SD)	Observation Mean (SD)	Imitation Mean (SD)
Replica Toys				
Demonstration Phase				
Imitation Frequency	0(0)	4.25(1.21)	.09(.30)	4.36(.81)
Average Imitation Fidelity	0(0)	2.60(.10)	.05(.15)	2.52(.38)
Percentage of Toys Imitated	0(0)	97.92(7.22)	2.27(7.53)	100(0)
Substitute Toys				
Demonstration Phase				
Imitation Frequency	0(0)	4.33(1.30)	.73(1.79)	4.09(.54)
Average Imitation Fidelity	0(0)	2.23(.42)	.25(.60)	2.41(.44)
Percentage of Toys Imitated	0(0)	95.83(9.73)	11.36(23.35)	97.73(7.54)
Control Toys				
Imitation Frequency	---	----	0(0)	5.00(1.70)
Average Imitation Fidelity	---	----	0(0)	2.3(.26)
Percentage of Toys Imitated	---	----	0(0)	100 (0)

Possible scores for:

1. Imitation Frequency ranged from 0-1 imitated pretense action in the observation conditions and from 3-8 imitated pretense actions in the imitation condition.

2. Average Imitation Quality ranged from 0, no imitation of the experimenter to 3, identical duplication of the experimenter’s actions

3. Percentage of Toys Imitated ranged from 0% in the observation condition to 100% in the imitation condition

3.2 PRELIMINARY ANALYSES

Preliminary analyses were conducted to test for specific toy effects, order effects and gender differences and testing location. Previous studies have shown gender differences on pretense tasks with girls demonstrating a more advanced understanding (Bornstein et al., 1996; Lowe, 1975; Taylor & Carlson, 1997).

3.2.1 Performance Difference across Toys

Three one-way repeated measures ANOVAs with toy as the within subjects factor, one for replica toys, substitute toys, and control toys, were conducted to examine whether toddlers selected some toys correctly more frequently than others. The dependent variable was the percentage correct toy choice.

For replica toys toddlers chose the bottle, hat, brush and phone correctly 58.60%, 35.70%, 53.00% and 45.6%, of the time respectively. There was a significant main effect for replica toy, F (3, 94) = 4.25, p = .008. Post-hoc comparisons (Bonferroni) indicated that toddlers tended to match pretense toy and referent correctly more frequently with the bottle (M = 58%) than with the hat (M = 36%, p < .10). No other comparisons between replica toys were significant.

For substitute toys, toddlers chose the stick, block, ball and box correctly 47.70%, 31.30%, 57.60% and 12.90%,of the time, respectively. Again, there was also a significant main effect for toy, F (3, 94) = 23.42, p < .001. Post-hoc comparisons (Bonferroni) indicated that the box was the most difficult toy (M = 12.9 %, p < .01 compared to the block M=31.3%, p<.01; stick (M = 47.7%, p<.01); ball (M = 57.6%, p <.01) or the block (M = 31.3%, p < .01) Children also answered correctly more frequently with the ball (*M* = 57.6%) than the block (*M* = 31.3 %, $p < .001$). No other comparisons between substitute toys were significant.

With the control toys, toddlers chose the baster top, pipe adapter, horseshoe and green ring correctly, 35.90%, 43.80% 53.20% and 40.80% of the time respectively. No performance differences between control toys were found, $F\ (3, 94) = .66$, $p = .59$.

3.2.2 Presentation Order

A 2 (toy type: replica, substitute toy) x 2 (presentation order: replica then substitute, substitute then replica) ANOVA was conducted with toy type as the within subjects factor and presentation order as between subjects factor. The dependent measure was the percentage correct toy choice. There was a significant main effect for toy type, $F\ (1, 96) = 9.17$, $p<.01$. In general children did better with replica toys than substitute toys. This main effect will be addressed in more detail in the following substantive analyses because it relates to one of the primary hypotheses. There was no significant main effect for presentation order, $F\ (1, 96) =.001$, $p<.96$). Children matched toys to their referents equally well whether the replica or substitute toys were presented first or last. However, there was a marginally significant interaction between presentation order and toy type, $F\ (1, 96) = 2.93$, $p<.10$; see figure 6).

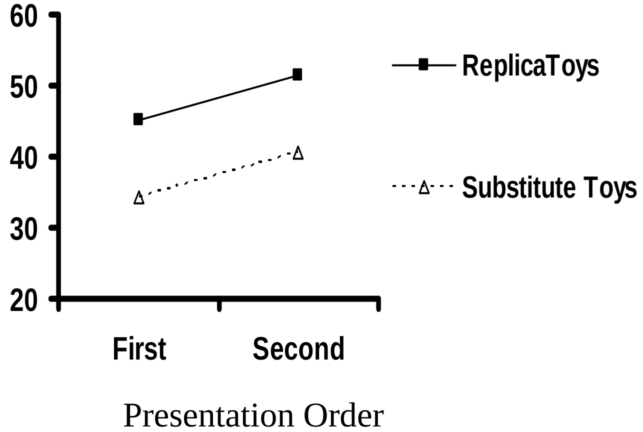


Figure 6. Interaction between presentation order and toy type

The effect of presentation order differed depending on the toy type. If children had replica toys presented first their mean percentage correct toy choice was 45.21% for the replica toys and 40.43% for the substitute toys. If children had substitute toys presented first their mean percentage correct toy choice for the replica toys was 51.67% and 34.40% for the substitute toys. The interaction between presentation order and toy type rests on children's performance when they received the substitute toys first. For the children who had the substitute toy presented first they struggled much more with the substitute toys (34.4%) and the difference between replica and substitute toy percentage correct toy choice (mean difference =17.27%) was statistically significant, $t=3.48$, $p<.05$. However, for children who had replica objects presented first the difference between replica and substitute toy percentage correct toy choice (mean difference = -4.78%) was not statistically significant, $t=.90$, ns. Moreover, because presentation order was counterbalanced within each demonstration and request condition, this interaction effect was unlikely to have played any role in differences in children's performance across conditions.

3.2.3 Gender comparisons

A 2 (toy type: replica versus substitute toy) x 2 (gender) ANOVA was conducted with toy type as within subjects factors and gender and age between subjects factor. The dependent measure was the percentage correct toy choice. This comparison revealed no significant main effect for gender, F (1, 96) = .80 p=.37 or significant interactions between gender and toy type, F (1, 96) = .80, p=.37. Thus, gender was not considered to play a role in children's performance. This is important because in some conditions girls outnumbered boys by one participant and in others boys outnumbered girls by one participant. Differences in children's performance between these conditions could not have been due to the presence or absence of children from one gender.

3.2.4 Comparison of children tested in child care centers and in the lab

A 2 (toy type: replica vs. substitute toy) x 8 (location of data collection: 6 child care centers vs. home vs. lab) ANOVA was conducted with toy type as the within subjects factor and the location of data collection as between subjects factor. The dependent measure was the percentage correct toy choice. Analyses revealed no main effect for the location of data collection, F (7, 90) = .66, p=.70. Regardless of where children were tested they performed equally well on the task.

In summary, preliminary analyses revealed that children matched some toys more frequently to the correct referents. With the replica toys, children found it easier to match the bottle and brush. With the substitute toys children found it easier to match the ball and the stick. Also, toddlers performed better with both toy sets if given the replica toys before the substitute toys. However, since the presentation of toy sets was counterbalanced across subjects, this was unlikely to have any effect for comparisons of children's performance across conditions. Preliminary analyses revealed no effect of gender or location of data collection for children's performance.

3.3 SUBSTANTIVE ANALYSES

The primary goal of the current paper was to test the role of motor perceptual input, both direct (imitative) and indirect (observational) for children's pretense re-presentation and comprehension.

Substantive analyses were conducted to test the five main hypotheses and are summarized below:

First, an omnibus analysis was conducted comparing children's correct toy choice performance for the observation vs. imitation demonstration conditions of the task, for the object vs. action request conditions of the task, and for replica vs. substitute toy types as well as by age (20 vs. 28 month olds).

Main effects were expected for the demonstration phase, with imitation condition (direct motor perceptual input) performance exceeding observation condition (no direct motor perceptual input) performance; for request phase with action condition (indirect motor perceptual input) performance exceeding object request (no indirect perceptual input) performance; for toy type with replica toy (rich visual perceptual input) performance exceeding substitute toy performance; and for age with older toddlers' (28 months) performance exceeding that of younger toddlers (20 month olds)

Three interactions were also expected: An interaction was expected between demonstration condition (observation vs. imitation) and request (object vs. action) condition. The difference between object and action request conditions was expected to be higher for children in the imitation demonstration condition than for children in the observation condition. Toddlers were expected to select the correct toy most frequently when they had received a combination of direct motor perceptual input from imitating in the demonstration condition and indirect motor perceptual input from seeing a pantomimed action request in the request condition.

An interaction was also expected between toy type (replica vs. substitute) and demonstration condition (observation vs. imitation). The difference between observation and imitation demonstrations was expected to be higher for children performing with substitute rather than replica toys. Toddlers were expected to selecting the correct substitute toy more frequently when given a chance to imitate with the substitute toys.

A three way interaction was expected between age, demonstration and imitation condition. Younger toddlers (20 months) were expected to select the correct toy more frequently when they participated in both the imitation and action request conditions (combination of direct and indirect motor perceptual support). Older children (28 months) overall were expected to select the correct toy more frequently in the action request conditions (indirect motor perceptual support) but the direct motor perceptual support from imitation was not expected to have as large an effect on their performance as for the younger (20 months) children.

Second, a complementary set of analyses was conducted to compare performance in each condition with chance. Although ANOVAs allow for comparisons of toddlers' performance between tasks, they do not reveal whether children actually comprehended the task in each condition. Comparing the percent correct toy choice with chance (in this case, 25% because there were 4 toys to choose from) allows us to determine in which conditions toddlers actually comprehended the task. Separate comparisons of 20 month olds and 28 month olds' *percentage correct toy choice* with chance performance were conducted within each condition.

The same predictions for the patterns of children's *percentage correct toy choice* across demonstration-request conditions were made as those articulated above: Younger (20 months) and older toddlers (28 months) were expected to perform above chance in more conditions with the replica than the substitute toys. Furthermore, older toddlers (28 months) were expected to perform above chance in more conditions than the younger toddlers (20 months).

Interactions between age and demonstration and request type were also expected. Specifically, younger toddlers (20 months) were expected to select both the replica and substitute toys above chance when they had a combination of imitation demonstration (direct motor input) with action request (indirect motor input) because of their hypothesized reliance on a combination of direct and indirect motor perceptual input. They were not expected to be able to perform above chance in conditions where they had no motor perceptual input, only direct motor perceptual input or only indirect motor perceptual input. Thus, they were not expected to perform above chance in the object request condition (no indirect motor input), or in the observation demonstration (indirect motor input) with an action request (indirect motor input).

However, older toddlers (28 months) were expected to select the correct toy if either direct *or* indirect motor perceptual input was available. They were not expected to need a combination of the two. Thus, 28 month olds were expected to perform above chance in the imitation demonstration (direct motor input) condition and with the action request (indirect motor input). That is, older toddlers were expected to perform above chance when they imitated the experimenter in the imitation demonstration condition (direct motor input) even in the object request condition (no indirect motor input) as well as they only watched the experimenter in the observation demonstration condition (no direct motor input) but were in the action request condition (indirect motor input).

3. Third, relations were assessed between percentage correct toy choice with the replica and substitute toy sets and imitation frequency, fidelity and percentage. Toddlers were expected to show better task performance when imitation frequency, fidelity and percentage imitated were higher, regardless of age

4. Finally, performance with the control toys was compared with chance performance. Children were not expected to be able to match toy and action just through simple association. Thus, they were not expected to perform above chance with the control toys

Analyses are presented below:

3.3.1 Children’s correct toy choice by demonstration and request conditions, toy type and age

A 2 (demonstration condition: imitation vs. observation) x 2 (request condition: object vs. action) x 2 (toy type: replica vs. substitute toy x 2 (age) mixed ANOVA was conducted to test for overall main effects and interactions. Demonstration and request conditions and age were between subjects variables while toy type was a within subjects variable. The dependent variable was the percentage correct toy choice. There was a significant main effect for age, *F* (1,

96) =7.18, p<.01 and toy type, *F* (1, 96) = .63, p<.01, as predicted.   In general, 28 month old toddlers outperformed the 20 month old toddlers (M=48% vs. M=37%, respectively) and selected the correct toy more often. Also, toddlers, regardless of age or condition, selected the correct replica toy (M = 48.00%) more frequently than they selected the correct substitute toy (M = 37.4 %).   However, contrary to predictions, there were no significant main effects of demonstration or request condition. Thus, direct or indirect motor perceptual input appeared to have no main effect on children's performance.

However, there was a marginally significant interaction between demonstration and request condition, *F* (1, 96) = 3.07, p=.08 (see figure 7) suggesting that direct and indirect motor perceptual input could play a role if used in combination.

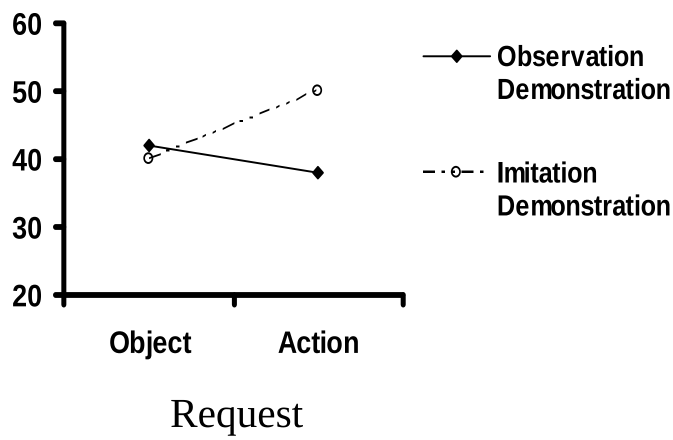


Figure 7. Interaction between demonstration and request conditions on percentage correct toy choice

This small interaction was driven primarily by the fact that percentage correct toy choice was higher if children in the imitation condition also received an action request (50.3%) vs. an object request (40.3%), respectively, t (46) = -1.75, p < .09). If children were in the imitation demonstration condition, they did much better with an action request than an object request. In contrast, for children in the observation demonstration condition it did not matter whether the request was presented with an object (M=40.3%) or an action M=37.8%, t (46) = ,73, p = ns. Furthermore, percentage correct toy choice was also significantly higher for children in the action request condition who received an imitation demonstration vs. an observation demonstration (mean difference = 12.50%, t (44) = -2.06, p<.05). There were no interactions between demonstration and request condition, between toy type and demonstration condition, and no three-way interaction between age, demonstration and request condition.

Thus, contrary to predictions there was no main effect for direct motor perceptual input (imitation) or indirect motor perceptual input (action request. However, this is not to say that direct or indirect motor perceptual input had no effect at all on children's performance. Rather, it appeared that direct and indirect motor perceptual input worked best when combined. Children's performance overall was significantly better if they received a combination of direct (imitation) and indirect (action request) motor perceptual input regardless of age or toy type.

Moreover, there was an unpredicted significant interaction between toy type and request condition, *F* (1, 96) = 11.69, p<.01; see figure 8).

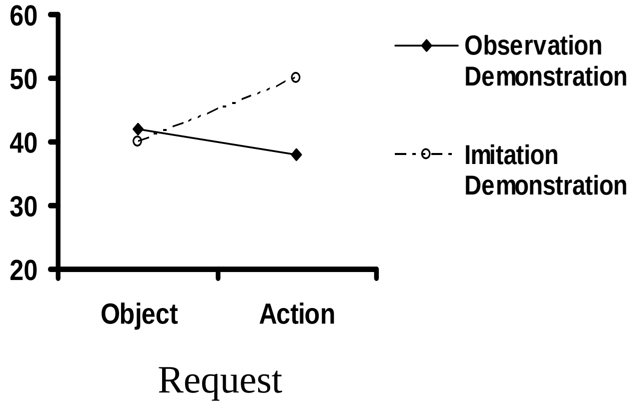


Figure 8. Interaction between request condition and toy type on percentage correct toy choice

With substitute toys, toddlers chose the correct toy more significantly frequently in the action request condition (M=44.80%) than the object request condition (M=30.10%), t (96) = -3.00, p<.01. However with replica toys the situation was reversed, toddlers chose the correct toy significantly more frequently in the object request condition (52.60%) than the action request condition (44.80%), however this mean difference was not statistically significant. Moreover, in the object request condition children performed significantly better with replica rather than substitute toys (22.6% mean difference, t (46) = 5.38, p<.01) but in the action request condition it the difference between replica and substitute toys was almost equivalent (mean difference = 1.50%, ns). Thus, the action request condition (indirect motor perceptual support) boosted toddler's percentage correct toy choice more when asked to understand pretense substitute rather than replica toys. Furthermore, there was no difference between toddlers' percentage correct toy choice with replica or substitute toy if they were given indirect motor perceptual support from the action request condition. However, in the object request condition, children appeared to perform better with replica rather than substitute objects.

In summary, in keeping with our predictions, main effects were found for age and for toy type. Overall, children selected the correct toy more frequently when they were older (28 months) and if they were matching replica toys to their referents rather than substitute toys. However contrary to our predictions there were no main effects for demonstration or request conditions. On their own direct motor support from imitation and indirect motor support from an action request, did not produce a higher percentage correct toy choice.

However, the roles of direct and indirect motor perceptual support appeared to be moderated by request condition and toy type respectively.   Children did perform better with direct motor perceptual support (imitation demonstration) if imitation was paired with indirect motor perceptual input (an action). And children did perform better with indirect motor perceptual support (action request) but only with substitute objects.   In contrast, an action request with replica objects seemed to reduce children's percentage correct toy choice and children found it easier to match replica objects to a referent object rather to a pantomimed action.

Moreover, although age was expected to interact with direct and indirect motor perceptual input, there was no evidence that 28 month olds, other than generally being better on the task, there was no evidence to suggest that they were performing any differently in the combination of demonstration and request conditions than 20 month olds.

In summary, there were main effects of age and toy type, with children performing overall better if they were older and if the task used replica objects, but no main effects for direct or indirect motor input. Furthermore, there was no evidence that 28 month olds were responding differently to the direct and indirect motor perceptual input than 20 month olds. However, children's performance did benefit from direct motor perceptual input from imitation but only if combined with indirect motor perceptual input from an action request. Moreover, children's performance did benefit from indirect motor perceptual input from an action request but only for substitute objects. In contrast, in general, children had more difficulty matching a replica toy to the correct action than to its referent object.

3.3.2 Comparisons of percentage correct toy choice selection with chance at each age and within toy type and each condition pair.

Although, ANOVA comparisons between demonstration and request conditions, age and toy type revealed the differences between conditions, they did not reveal in which conditions toddlers actually comprehended the task and performed above chance. In order to know when children understood the task and when they did not, we needed to compare children's performance in each condition with chance performance.

Thus, one-sample t tests were conducted to compare children's performance in each of the 4 demonstration-request condition combinations with chance at each age, 20 and 28 months. The dependent variable was the percentage correct toy choice for replica and substitute toys. Because four choices were available in every trial, percentage correct toy choice was compared with chance performance of 25.00%.

Younger toddlers' (20 months) mean percentage correct toy choice, are presented in table 5 and in figure 9 with corresponding t-test statistics.

Table 5. Comparison of correct toy performance in each demonstration-request condition at 20 months.

Toy Type	Demonstration Condition	Request Condition	Correct Toy Percentage	t	df	p
Replica Toys	Observation	Object	50.00	3.32	11	<.01
		Action	25.00	0	11	ns
	Imitation	Object	48.08	2.48	10	<.05
		Action	42.31	2.92	11	<.05
Substitute Toys	Observation	Object	25.00	0	11	ns
		Action	37.50	1.63	11	ns
	Imitation	Object	26.92	.56	10	ns
		Action	42.00	2.92	11	<.05

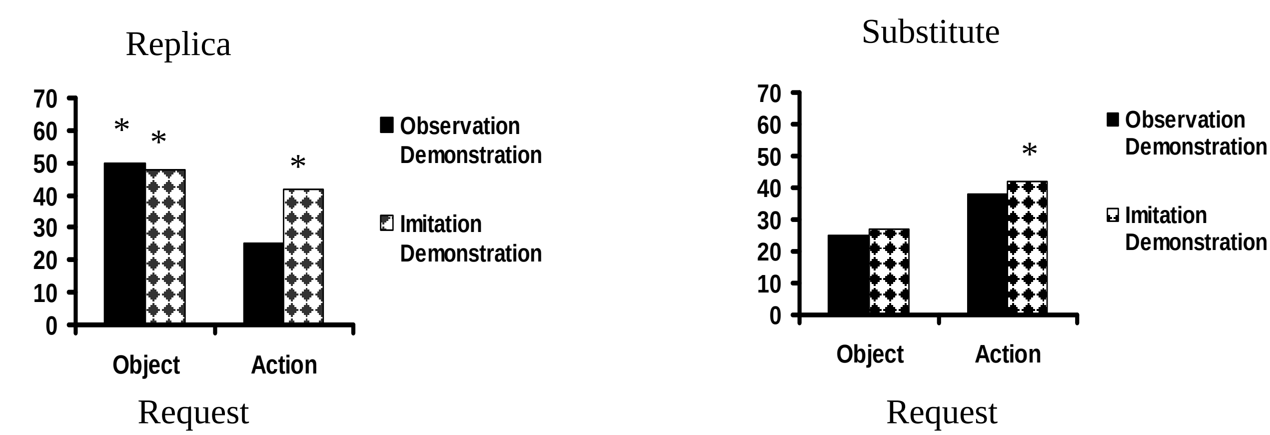
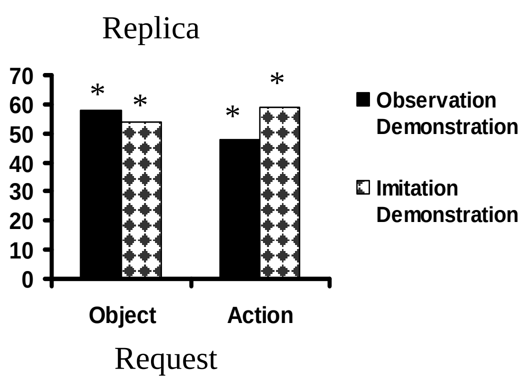


Figure 9. Percentage of correct toy choice by toy type, demonstration condition and request condition at 20 months of age (p<.05)

Older toddlers' (28 months) mean percentage correct toy choice, with corresponding t-test statistics for each combination of demonstration and request conditions and with each toy type are presented in table 6 and in figure 10.

Table 6. Comparison of correct toy performance in each demonstration-request condition at 28 months.

Toy Type	Demonstration Condition	Request Condition	Correct Toy Percentage	t	df	p
Replica Toys	Observation	Object	57.69	3.98	12	<.01
		Action	47.73	3.98	11	<.05
	Imitation	Object	54.17	2.88	10	<.05
		Action	59.09	4.89	10	<.01
Substitute Toys	Observation	Object	36.54	1.56	12	ns
		Action	40.91	1.88	11	<.09
	Imitation	Object	31.25	.76	10	ns
		Action	61.36	5.16	10	<.01



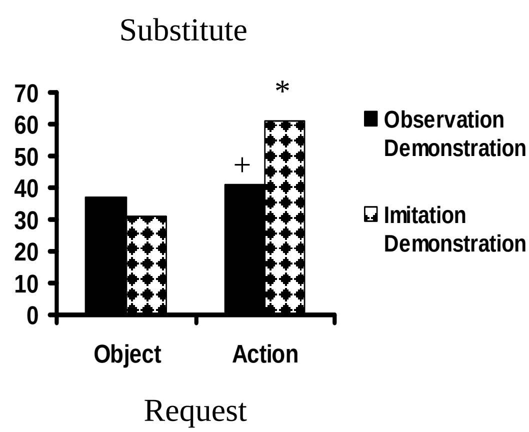


Figure 10. Percentage of correct toy choice by toy type, demonstration condition and request condition at 28 months of age (*, p<.05; +, p<.10)

Younger (20 months) and older toddlers (28 months) were expected to perform above chance in more conditions with the replica than the substitute toys because of the assistance from visual perceptual input. Consistent with our hypotheses, 20 month olds performed above chance in 3 out of the 4 demonstration-request conditions in the replica toys but only 1 of 4 demonstration-request conditions in the substitute toys.

Older toddlers (28 months) performed above chance in all 4 demonstration-request conditions with the replica toys but in only 1 of 4 demonstration-request conditions with the substitute toys (with one demonstration-request condition approaching significance). Complementing the ANOVA findings of a main effect for toy type, replica toys were chosen above chance performance in more conditions than were substitute toys.

Furthermore, older toddlers (28 months) were expected to perform above chance in more conditions than the younger toddlers (20 months) did. Consistent with our hypotheses, 28 month olds performed above chance in 5 out of the 8 demonstration-request conditions (with an additional 6^{th} approaching significance) while 20 month olds performed above chance in 4 of 8 demonstration-request conditions. Complementing the ANOVA findings of a main effect for age, 28 month olds chose the correct toy above chance in more conditions than 20 month olds did.

Younger toddlers (20 months) were expected to select the correct replica and substitute toys above chance performance when they had a combination of an imitation demonstration (direct motor input) with an action request (indirect motor input). Expectations were not met for the replica toys. Indeed, 20 month old toddlers were able to select the correct replica toy above chance levels when an imitation demonstration (direct motor input) was combined with an action request (indirect motor input). However, they were also able to choose the replica toy above chance even in the object request conditions (with no direct or indirect motor input).

But, with the substitute toys, our expectations were met. Younger toddlers (20 months) only performed above chance with substitute toys if the imitation demonstration (direct motor input) was combined with an action request (indirect motor input). They did not perform above chance in any other combination of demonstration and request complementing the ANOVA findings.

Older toddlers (28 months) were expected to select the correct toy if they participated in either an imitation demonstration (direct motor input) *or* an action request (indirect motor perceptual input). Unlike 20 month olds, they were not expected to need a combination of the two. Once again, expectations were not met for the replica toys. Older toddlers (28 months) were able to select the correct replica toy at above chance levels in any combination of demonstration and request conditions and thus, without any motor input. But, expectations were partially met for the substitute toys. Like younger toddlers, older toddlers only performed above chance with substitute toys in the imitation demonstration (direct motor input) combined with an action request (indirect motor input). But, being in the imitation condition (direct motor input) did nothing to boost their performance when paired with an object request (no indirect motor input). However, they were marginally significantly above chance when the reverse was true. Thus, with substitute toys, they appeared almost capable being able to select the correct substitute toy with only indirect motor perceptual input in the action request condition. .

In summary, percentage of correct toy performance was above chance in more conditions with the replica toys than with substitute toys at each age. Older toddlers (28 month olds) performed above chance in more conditions than younger toddlers (20 month olds). Overall, 20 and 28 month old toddlers did well with the replica toys in all conditions with the exception of the observation demonstration combined with an action request at 20 months of age. With substitute toys, both 20 and 28 month olds chose the correct toy only when an imitation demonstration and action request were combined.

3.3.3 Imitation variables

Relations between percent correct toy choice and imitation were assessed using inter-correlations between percentage of correct toy choice for replica and substitute toys and imitation frequency, imitation fidelity and the percentage of toys imitated. We had expected that when children engaged in more frequent, more faithful imitation with a greater percentage of toys, they would select the correct toy more often. The imitation variables were highly significantly related to each other (see Tables 7 and 8 for inter-correlations for replica toys and substitute toys respectively). However, there were no significant relations between imitation frequency, imitation fidelity, percentage of toys imitated and percent correct toy choice.

Table 7. Replica toys: Inter-correlations between percent correct toy choice and imitation variables (N=97)

	1	2	3	4
1. Percent Correct Toy Choice	…			
2. Imitation Frequency	.06	…		
3. Average Imitation Fidelity	.05	.93***	…	
4. Percentage of Toys Imitated	.04	.95***	.98***	…

***, $p<.001$

Table 8. Substitute toys: Inter-correlations between percent correct toy choice and imitation variables (N=97)

	1	2	3	4
1. Percent Correct Toy Choice	…			
2. Imitation Frequency	.10	…		
3. Average Imitation Fidelity	.14	.92***	…	
4. Percentage of Toys Imitated	.09	.94***	.98***	…

***, $p<.001$

This may have been due to a ceiling effect for imitation. In general, the manipulation of action in the demonstration conditions was quite successful (please see Tables 3 and 4). Toddlers imitated in the imitation condition but not in the observation condition. However, it may have not produced enough variability in the imitation variables to establish a true relationship between imitation frequency, fidelity and percentage imitated with the percentage correct toy choice that might be existent in naturally occurring play interactions. Introducing a 0-5 scale of imitation fidelity rather than the 0-3 scale used also could have produced more variability in the imitation scores but would have created a greater challenge for coding reliability.

In summary, imitation variables were unrelated to toddlers' performance on the task.

3.3.4 Associative Learning: Object and Action

One of the downsides of the paradigm used was that toddlers' performance in the action request condition could be due to a lower-level mechanism of simple toy-action matching rather than the involvement of any pretense re-presentation. To address this problem, a control toy set was introduced to measure toddlers' capacity to create a simple association between toy and action. Thus, this control toy set was only used in the action request condition. Toddlers were not expected to match toy and action through simple association: ie, they were not expected to perform above chance with the control toys.

T-tests were conducted to compare children's performance on the control toys to chance. The dependent variable was the percentage correct toy choice for control toys. Because four choices were available in every trial, the percentage correct toy choice selected was compared with chance performance of 25.00%. Surprisingly, toddlers were able to match the control toys to actions, M=48.90%, $t(45) = 3.31$, $p<.05$. This was an unexpected finding.

Because we had previously a found main effect of age on toddler's ability to match replica and substitute toys with action requests, follow-up analyses examined 20 and 28 month olds' ability to choose the correct control toys separately. T-tests were conducted first to compare younger toddlers' (20 months) percent correct control toy choice with chance and then older toddlers' (28 months) percent correct control toy choice with chance.

Younger toddlers (20 months) were not able to select the control toys at above chance levels suggesting that their performance with replica and substitute toys in the action request condition was not due to simple associative learning (M = 36.84% correct, t (23) =4.22, p < .01). However, older toddlers (28 months) were able to select the control toys at *above chance levels* (M = 50.00 % correct, t (23) =4.22, p < .01) suggesting that they were capable of learning a simple association between object and action during the task.

Could 28 month olds capacity for simple associative learning explain their ability to choose the correct replica and substitute toys in action request conditions? Follow-up inter-correlations assessed whether 28 month olds' ability to match toys and actions was related to their performance with replica toys and substitute toys. Older toddlers' (28 months) correct control toy percentage predicted their correct toy choice percentage with replica, r (22) =.72, p<.001, but not substitute toys, r (22) =.28, p=.22.

In response to this unexpected finding, additional follow-up analyses were run to examine the role of demonstration condition on all children's percentage correct toy choice while controlling for the capability to match control objects with actions. Because, the control toys were administered to only children in the action request condition and not to children in the object request condition, I was only able to control for associative learning in the subgroup of children who received an action request.

A 2 (demonstration condition: imitation vs. observation) x 2 (toy type: replica vs. substitute toy) x 2 (age) mixed ANCOVA with percentage correct toy choice as the dependent factor and percentage correct choice on control toys as the covariate was conducted to test for overall main effects and interactions. There was a main effect of demonstration condition $F(1, 46) = 11.02$, $p<.01$, when percentage correct toy choice for control toys was controlled such that children in the imitation condition had a significantly higher correct toy percentage. Specifically, when associative learning is controlled for children who experienced direct motor perceptual input showed approximately 20% better percentage correct toy performance (62.80%) in matching toys to actions than did children in the observation condition (41.80%), $F(1,20)=11.20$, $p<.01$.

In other words, if associative learning is controlled for, there is a main effect of direct motor perceptual input (imitation demonstration condition) but only among children who also later receive indirect motor perceptual input (the action request condition). In contrast to previous analyses, which found no main effect for imitation, restricting the sample to children who only participated in the action request condition and controlling for children's facility with associative learning, showed that direct motor perceptual input can have an effect on children's pretend play comprehension.

In summary, we unexpectedly found that 28-month-old but not 20-month-old toddlers were capable of learning a simple association between toy and action during the course of the task. Furthermore, the capacity to learn this simple association predicted 28 month olds ability to correctly match a replica toy but not a substitute toy to its referent action. However, when simple association was controlled for, there is a main effect of direct motor perceptual input on all children's correct toy performance within the action request condition. This partially supports the hypothesis that direct motor perceptual input can help facilitate children's understanding of pretense.

3.3.5 Toddlers' Errors

In examining the possibility of associative learning between object and action, another associative learning possibility was discovered. In particular, because all of the pretend actions were being performed to the body, children may have learned a simple association between the toy and the body part. This association would be most problematic for the action request condition of the task. Viewed from the body location perspective, the experimenter could be demonstrating the pretense action with the replica or substitute toy to a location on the body, and then be in essence "pointing" to this body part when demonstrating the pantomimed action request. For example, when the experimenter requested a brush by pantomiming brushing her hair, the child may have chosen either a brush or a hat simply because they had learned that the toy and the head go together. This was of particular significance for the replica toys. Two of the toys were associated with actions to the head (brush and hat) and two were associated with actions to the mouth (phone and bottle). However, this association was less of a consideration for the substitute toys, only the stick/toothbrush and ball/apple were both associated with actions to the mouth. The block and ball toys were directed towards very different body parts.

This possibility was not planned for and controlled for methodologically but was examined statistically. Fortunately, the object request condition offered a convenient control to examine the possibility of associative learning between toy and body part. In the object request condition, toys were requested with an object and no body part was "pointed" to with an action. Therefore, we could examine whether the pattern of errors between these two conditions differed and thus, whether children were merely associating body part with the toy when making their choice. To that end a confusion matrix was created which articulated the types of errors children are making with each toy set (see Tables 9 and 10).

Table 9. Replica toy confusion matrices. Frequency with which each replica toy was selected following a specific request, for both request conditions, (N=96) , for object request only (N=48)and for action request only (N=48).

Both Request Conditions

	Selected Toy				
Requested Toy	No Toy	Bottle	Hat	Phone	Brush
Bottle	6.52%	53.26%	7.61%	17.39%	15.22%
Hat	14.44%	15.56%	34.44%	14.44%	21.11%
Phone	7.61%	17.39%	9.78%	41.30%	23.91%
Brush	8.70%	13.04%	13.04%	13.04%	52.17%

Object Request Condition

	Selected Toy				
Requested Toy	No Toy	Bottle	Hat	Phone	Brush
Bottle	4.17%	66.67%	6.25%	10.42%	12.50%
Hat	19.57%	10.87%	41.30%	10.87%	17.39%
Phone	12.50%	12.50%	6.25%	47.92%	20.83%
Brush	12.50%	18.75%	8.33%	6.25%	54.17%

Action Request Condition

	Selected Toy				
Requested Toy	No Toy	Bottle	Hat	Phone	Brush
Bottle	9.09%	38.64%	9.09%	25.00%	18.18%
Hat	9.09%	20.45%	27.27%	18.18%	25.00%
Phone	2.27%	22.73%	13.64%	34.09%	27.27%
Brush	4.55%	6.82%	18.18%	20.45%	50.00%

Table 10. Substitute toy confusion matrices. Frequency with which each replica toy was selected following a specific request, for both request conditions, (N=96) , for object request only (N=48)and for action request only (N=48).

All Request Conditions					
	Selected Toy				
Requested Toy	No Toy	Stick	Block	Ball	Box
Stick	8.70%	45.65%	7.61%	34.78%	3.26%
Block	16.30%	16.30%	35.87%	30.43%	1.09%
Ball	10.99%	17.58%	8.79%	59.34%	3.30%
Box	16.67%	21.11%	16.67%	34.44%	11.11%
Object Request Condition					
	Selected Toy				
Requested Toy	No Toy	Stick	Block	Ball	Box
Stick	12.50%	39.58%	6.25%	37.50%	4.17%
Block	25.00%	20.83%	25.00%	29.17%	0.00%
Ball	18.75%	20.83%	6.25%	54.17%	0.00%
Box	23.40%	21.28%	21.28%	27.66%	6.38%
Action Request Condition					
	Selected Toy				
Requested Toy	No Toy	Stick	Block	Ball	Box
Stick	4.55%	52.27%	9.09%	31.82%	2.27%
Block	6.82%	11.36%	47.73%	31.82%	2.27%
Ball	2.33%	13.95%	11.63%	65.12%	6.98%
Box	9.30%	20.93%	11.63%	41.86%	16.28%

General log linear analyses were run to examine the patterns between the requested and selected toy and to evaluate whether demonstration or request condition predicted the types of errors children were likely to make. The general log linear analysis procedure could therefore analyzes the frequency counts of correct selection and errors in a contingency table and identifies which frequencies occur beyond expectations across toys. This procedure was first run for replica toys and then repeated for substitute and control toys. Chi-squares for comparisons between object and action request errors are presented in table 11.

Table 11. X2s for Object vs. Action Request Comparisons for Toy Errors

		Object Vs. Action Comparisons			
		Toy Selected			
Replica Objects		Bottle	Hat	Phone	Brush
	Bottle	---	0.32	3.22	0.63
	Hat	.87	---	0.48	0.27
	Phone	0.92	0.97	---	0.14
	Brush	3.14	1.36	3.14	---
Substitute Objects					
		Stick	Block	Ball	Box
	Stick	---	0.14	0.50	0.34
	Block	2.25	---	.07	.01
	Ball	1.33	.37	---	0.01
	Box	1.97	0.68	0.57	---

For replica errors there was no evidence that children were choosing on the basis of location when they were asked for the bottle, brush, hat, and phone toys. In general, there were no significant differences between the frequency of errors for each replica toy distracter when comparing object and action request conditions (see table 11). Furthermore, within each request condition for each toy, bottle, brush, hat and phone, there were no significant differences in the frequency of errors in selecting one of the other distracter toys.

For substitute toys, there was also no evidence that children were choosing on the basis of location when they were asked for the stick, block, ball and box. In general, there were no significant differences between the frequency of errors for each substitute toy distracter when comparing object and action request conditions (see table 11). However, analyses demonstrated that when certain substitute toys were requested through an object or action request, the likelihood that children would choose one of the 3 distracter toys was not equal. In particular, as seen in table 10, children were most significantly more likely to pick the stick or the ball in error and were highly unlikely to select the block in error. However, this pattern did not demonstrate a preference for the toy which matched the same body part but rather, children's overall preference for the stick and ball distracters and disregard for the box distracter regardless which toy was requested.

In summary, while children could have used the strategy of matching the toy to location in order to decipher the experimenter's pantomimed action request, the data overall do not support such a conclusion. Therefore, although this possibility of location matching was not controlled for methodologically, it was unlikely to have played a large role on children's toy selection.

4.0 DISCUSSION

The overarching goal of the current paper was to examine whether children's actions with toys and corresponding motor perceptual input could support their pretense representations. One of the primary hypotheses was that direct motor perceptual input from imitating pretense actions and indirect motor perceptual input from an action request would facilitate toddlers' pretense re-presentations and thus, their ability to match pretend toys to referent objects and actions. In particular, I expected motor perceptual input to have a direct and main effect on children's correct toy choice and thus, their pretense re-presentation, regardless of age, or pretend toy.

4.1 MAIN EFFECTS

My expectations were partially met. The results of the current study demonstrate that, on their own, direct and indirect motor perceptual input do not have a main effect on children's pretense representation at 20 and 28 months of age. Simply imitating an action or watching an adult pantomime an action is not enough by itself to boost children's pretend play representation and subsequent comprehension with all toys. However, interestingly, direct and indirect motor perception can help support pretense representation under the right circumstances (to be described further).

However, there were main effects for both age and toy type. In general, older toddlers (28 months) performed better on the task more often than younger toddlers (20 months). I had hypothesized that as toddlers' pretense re-presentations become more robust with age they would be less reliant on direct motor perceptual input but would still need indirect motor input to engage in pretense re-presentation but there was no statistical evidence to support this interaction. Furthermore, in general, confirming our expectations and supporting the process of "de-contextualization" described in the descriptive literature on pretend play development (Belsky & Most, 1981; Elder& Pederson, 1978; Fenson, 1984; Fenson & Ramsey, 1980; Jackowitz & Watson, 1980; Piaget ,1965; Ungerer et al., 1981), toddlers matched replica toys correctly to referents more than they matched substitute toys to referents.

4.2 INTERACTIONS BETWEEN DIRECT AND INDIRECT MOTOR PERCEPTUAL INPUT

Although there was no main effect for imitation, direct motor perceptual input (imitation) did affect children's performance but this effect was moderated by request type. Only if imitation was paired with an action request did children demonstrate modestly improved performance on the task. In fact, overall, of the four demonstration-request condition pairs, children showed the best percentage correct toy choice when imitation and action where paired together. Thus, direct motor input from imitation and indirect motor input from observing another's action appear to work synergistically to bootstrap children's understanding of pretend play. Moreover, if children's capacity for associative learning is controlled for statistically, this modest effect appears even more robust. Thus, the direct motor perceptual input of imitation does appear have a significant effect on children's performance on the task, above and beyond any capacity for associative learning. However this effect is only present if direct motor input is also matched with indirect motor perceptual input. Twenty and 28 month old toddlers pretend re-presentations are facilitated by motor perceptual input but only when there is a combination of both direct and indirect motor perceptual input.

In order to illustrate this finding, let's return to the example of pretending a toy is a car used in the initial exposition of embodied pretend play cognition. In general, opportunities to move with the toy will only assist toddlers' representation of the absent car when they also have subsequent opportunity to watch another person's car-like movement with the toy. Thus, the combination of direct motor perceptual input from imitation of a lateral back and forth activity and watching other person's car-like actions boosts their ability to engage in pretense re-presentation of the absent referent objects. The importance of direct motor perceptual input depends on children's additional opportunities to watch others engage in pretense action. This finding highlights the need for early pretend play to be grounded within a social context.

4.3 INTERACTIONS BETWEEN DIRECT AND INDIRECT PERCEPTUAL INPUT AND TOY TYPE

Indirect motor perceptual input (action request), on the other hand, was moderated by toy type, replica or substitute toys. Only if action requests were used with substitute objects did children demonstrate improved performance on the pretend play task. Furthermore, children's performance with both replica and substitute objects was equivalent if an action request was used. However, overall, children demonstrated the best performance when asked to match replicas to their referent objects.   When visual perceptual input was rich, as when replica objects and their referents were in the same visual field, visual perceptual input provided the best support for children's pretend re-presentations. However, if visual input from the toy was slightly diminished, substitute objects, toddlers did best if they also had the additional support of indirect motor perceptual input.   So to return to the car example, matching a replica car to its referent does not require indirect motor perceptual input from watching another's action. But if young toddlers watch an adult engage in a pretend action of object substitution in which the adult pretends a block is a toy car, toddlers are likely to need to see the action again and re-experience the indirect motor perceptual support in order to re-present the toy car.

In addition, although a three way interaction between direct motor perceptual input, indirect motor perceptual type and toy type was not statistically significant when comparing within and across groups, complementary analyses comparing children's performance with chance performance revealed that the interaction between direct and indirect motor perceptual support (described earlier) was also primarily driven by children's performance with substitute toys. Direct motor perceptual from imitation did very little to boost toddlers' understanding of pretense with replica toys because they were already quite good at matching replica toys.

Although we did not expect that motor perceptual input would have no effect on children's comprehension of pretense with replica toys, we did predict that motor perceptual input would be more important for children's pretend play with substitute toys. It appears that this was the case. When visual perceptual support is rich, as is the case with toddlers' pretending with replica objects, toddlers do not need motor perceptual input to engage in pretense re-presentation and comprehend pretend play. However, when toys are visually dissimilar from their referents, such as with substitute toys, toddlers are much more reliant on the combination of direct and indirect motor perceptual input to support their comprehension of pretense. In particular, toddlers at both ages only performed above chance with the substitute toys if they had a combination of imitation (direct motor perceptual input) and an action request (indirect motor perceptual input).

Although we had expected that the frequency and fidelity of imitation would predict how toddlers performed on the task, this did not prove true. This may reflect a lack of variation in the frequency quality of children's imitation or it may be that simply approximating the action once or twice in a semi-faithful way is enough direct motor perceptual input. It would be interesting to know whether variability in children's imitation frequency and quality in naturally occurring play contexts could predict children's comprehension of the task but the demands of the current task did not allow for much variability on either measure.

Finally, I expected that toddlers' performance on this task could not be explained purely by their ability to learn a simple association between object and action but that children would need to engage in pretense representation in order to comprehend the paradigm. This was true for 20-month-old toddlers. They were unable to perform above chance levels with the control toys. However, I was surprised when by 28 months toddlers could match novel control toys to the experimenter's pantomimed actions, even though they had only seen the toy-action pair for the first time during the demonstration phase of the task.

However, 28 month olds correct performance on this simple association task with novel toys was related to their ability to match replica but not substitute toys to actions. Although, 28 month olds' ability to make a simple association between toy and action may account for why they were able to match replica toys to actions, it does not account for their ability to match substitute toys to others' actions suggesting that children's apparent understanding of object substitution pretense at this age is not accounted for by learning a simple association between toy and action. Furthermore, the other associative learning possibility that children are not engaging in pretense re-presentation but simply matching the object to the appropriate body part was also examined by examining children's errors to look for systematic patterns. There was no evidence to support the body part matching hypothesis.

To summarize, direct motor input from imitation did support toddlers' pretense representation in certain contexts. In particular, imitation supported children's understanding of pretense when children played with substitute toys and when they were asked to match toys to actions. At 20 and 28 months, motor perceptual input rather than being purely a consequence of pretend representation can help guide pretense re-presentations when children play with substitute toys that are de-contextualized from their referents. When children play with substitute toys and both direct and indirect motor perceptual input is absent, they appear to have more difficulty engaging in pretend play re-presentation and thus, are not able to match substitute toys to their referent objects.

In contrast, toddlers' understanding of pretense with replica objects at this age is largely independent of motor perceptual input. It may be that the rich visual input children receive from replica toys and the physical resemblance of replica toys to their referents outweighs the need for motor perceptual input. It may also be that toddlers have a lot of motor practice pretending with replica toys and do not benefit from the motor input generated during this task. In general, toddlers able to match replica toys to both objects and actions and with replica toys, and thus, show pretense re-presentation with no motor input with replica objects.

4.4 LIMITATIONS

Although results of the current study do provide some support for a perceptual simulation account of pretense re-presentation they do not allow us to directly test this proposal. It may be that some other cognitive process, other than perceptual simulation could explain the pattern of results found in the current study and that motor and visual simulation are not involved at all. However, at this point in developmental social neuroscience, we do not have the methodology to directly test whether the motor and visual perceptual systems associated with performing pretense action are engaged when observing another's pretend play action. Because of movement artifacts found in fMRI and PET studies, measuring toddlers' brain activity in response to watching pretense actions would be next to impossible (Johnson, 2000). Furthermore, ERP data, while interesting, could only give us unlocalized data on the neural activity found in pretend play engagement (Carver & Bauer, 2004).

4.5 EMOBIDIED PRETEND PLAY IN EMPIRICAL AND SOCIAL CONTEXT

Despite our inability to test of possible perceptual simulation directly such as could be found through neuroscience methods, the current findings do point to a complex interrelationship between both motor and visual elements for pretend play development. Furthermore, re-conceptualizing pretense representation as perceptual simulation provides a new lens by which to view at the dynamic system of perceptual input that children need in order to engage in pretend-representation at any point in time, both within a single play session and across early development. The results from the current study demonstrate that children's pretense is not simply affected by one single perceptual factor but that both motoric and visual perceptual input can work in synergy or antagonistically depending on the toy and social context.

In addition, the sometimes perplexing findings that children demonstrate across tasks of pretense comprehension also reflect the complexity of the interdynamic system of pretend play representation. Thus, the variation seen in toddlers' comprehension of pretense across paradigms is not just noise nor is it due to methodological inadequacy (Harris & Kavanaugh, 1993; Leslie, 1987; Lillard, 2001; Nichols & Stich, 2000; Perner, 1991; Tomasello, Striano & Rochat, 1999, Watson & Fisher, 1977) but truly represents young toddlers' dependence on both motor and visual perceptual input to engage in pretense re-presentation or perceptual simulation. Toddlers do not just "have" the capacity for pretend play representation, their emergent understanding of pretense is jointly constructed with their physical and social environment. Moreover, the current results also converge with empirical reports the increasing visual decontextualization of toddlers' pretense with objects (Belsky & Most, 1981; Elder& Pederson, 1978; Fenson, 1984; Fenson & Ramsey, 1980; Jackowitz & Watson, 1980; Piaget ,1965; Ungerer et al., 1981).

Perhaps the best way to explain the current findings is to apply them in context. Imagine a group of toddlers, 20 and 28 months of age, playing pretend with a parent, babysitter or teacher. Toys both visually similar to their referents such a replica baby's bottle, brush, hat and toy phone receiver, and others not so defined such as a block, stick, ball and box are scattered around the rug on floor. What happens if an adult makes a bid for children to play pretend with her with these toys? When do they understand her goals, her intentions? When do they have the capacity for pretend re-presentation?

Unlike current theory and research on pretend play, which assume that toddlers' pretense capacity for pretend re-presentation and comprehension develops at one age and should apply equally well to all toys and environmental contexts (Harris & Kavanaugh, 1993; Leslie, 1987; Lillard, 2001; Nichols & Stich, 2000; Perner, 1991), embodied pretend play theory predicts that toddlers' ability to demonstrate pretense representation depends on the opportunities for perceptual input present in the physical and social environment. The current study provides systematic support for this theory by demonstrating that toddlers' capacity for pretend play comprehension depends not just on the age of the child but also on what adult partners do with the toys, how they make bids for pretend play engagement, which toy is used, and what the child does with the toy.

By re-conceptualizing pretend play representation as re-presentation or simulation of perceptual information, we can begin to explain toddlers' performance on different pretend play comprehension task varies. In particular, in keeping with other findings in the pretense literature, the current study suggests that children begin to be able to understand pretend play around 18-22 months with increased levels of motor and visual perceptual support (Watson & Fisher, 1977; Rakoczy & Tomasello, 2006) and their capacity for pretense representation becomes robust and less dependent on perceptual input by the time children are 26-29 months of age (Harris & Kavanaugh, 1993; Rakoczy & Tomasello, 2006; Walker-Andrews and Kahana-Kalman, 1999). Although the current study has begun to explain when and which combination of visual and motor perceptual input either facilitates or decreases children's pretend play comprehension, further research is necessary to fully articulate which perceptual and social elements are necessary and sufficient.

However, the current study does highlight the under-examined role that motor perceptual input plays for children's pretend play performance. Although, Piaget originally articulated a possible motor component of initial pretend play competence (Piaget, 1945), this element of pretend play has almost never been experimentally manipulated (Tomasello et al., 1999). The current study is the first to manipulate the role of direct motor perceptual input or imitation on children's pretend play performance. From the current results, motor perceptual inputs both direct and indirect, played a modest role in children's understanding of the pretend play task. Furthermore, motor perceptual input in this age group, did little to support children's pretend play with replica objects. However, when direct motor perceptual input from imitation was combined with indirect motor perceptual input both served to bootstrap children's performance, especially with substitute objects. This suggests that children's imitation of acts of object substitution at 20-28 months are not just blind mimicry but instead reflect toddlers' developing capacity for object substitution pretense when motor input is present.

4.6 COMMON CODING AND THE SOCIAL ENVIRONMENT

Furthermore, the description of indirect motor perceptual support as a visual cue to activate their own internal motor simulation of another's action (indirect motor input), has much in common with emerging common coding theories (Blakemore & Decety, 2001; Knoblich & Sebanz, 2006; Metzoff & Decety, 2003.). The current results may also inform our understanding of how common coding develops.

There is growing empirical evidence that when adults observe others' actions, they simultaneously simulate others' actions internally (common coding theory, Prinz, 2002;

Knoblich & Sebanz, 2006) and that this ability may be driven by mirror neurons (Meltzoff & Decety, 2003; Rizzolatti, Fadiga, Gallese & Fogassi, 1996). Furthermore, beyond a simple motor resonance, common coding is thought to support understanding of the goals of others' actions (Blakemore & Decety, 2001; Knoblich & Sebanz, 2006; Metzoff & Decety, 2003) and assist adults in predicting the outcomes of others' actions (Kilner et al., 2004 Sebanz, Bekkering, & Knoblich, 2006; Wilson & Knoblich, 2005;).

However, the developmental story for common coding is relatively uncharted empirically. Some have suggested that neonatal imitation represents an innate motor resonance between newborns' and others' actions (Longo & Bertenthal, 2004; Meltzoff & Decety, 2003) and that imitative action is enacted common coding (Metzoff & Decety, 2003). Moreover, other researchers have demonstrated empirically that an observation/execution matching system is in place at least by 9-12 months of age (Longo & Bertenthal, 2006; Somerville & Woodward, 2005). By 9 months of age, action perception influences infants' action production (Longo & Bertenthal, 2006) and by 10-12 months of age, infants' action production influences their action perception (Somerville & Woodward, 2005).

The current study also provides some additional developmental support for common coding proposals. Specifically, it may be that the indirect motor perceptual input hypothesized to result from watching another's action is really the result of motor resonance or common coding between one's own and another's action. Thus, in observation demonstration and the action request condition, toddlers may have simulated the experimenter's action with pretend objects.

This common coding appears to have helped them understand the goal of the experimenter's actions with replica toys. In general, they were able to match toys to referents without performing the action themselves suggesting that simply watching the experimenter's actions was enough for them to understand the goal of her behavior. However, with substitute toys, common coding alone wasn't enough to permit them to understand the goal of the experimenter's action. Complementing Somerville & Woodward (2005) finding, toddlers' action production facilitated their action understanding. Toddlers understood the experimenter's goal best when they physically produced the action. Thus, common coding with substitute toys needed to be enacted rather than simply simulated. Furthermore, adult neuroscience studies of the mirror system have shown that common coding is more strongly activated for adults when watching actions that they have previously performed (Repp & Knoblich, 2005) and are expert in (Calvo-Merino, Glaser, Grezes, Passingham & Haggard, 2005). It may be that until toddlers gather expertise with pretend play acts of object substitution, they need to produce the action in order to perceive the goal of others' pretend play acts with substitute toys.

Thus, the current study provides some complementary evidence that a common coding or observation/execution matching system is in place with pretend play actions in early childhood. Moreover, it also demonstrates that toddlers' expertise with pretend play actions and their production of the action affect their comprehension of pretense.

4.7 COMPARING THE "WORMY" AND "CHUTE" TASKS

The current findings also replicate and extend many of the findings in the original Tomasello et al. (1999) paradigm. In both studies toddlers also did better at matching replica toys to their referents than matching substitute toys to their referents.

However, there was also one striking difference between children's performance on the "chute" and "Wormy." tasks. In the original study, younger children were not able to match replica toys to their referent objects (e.g. match a replica brush to a large brush) but were able to match replica toys to actions (e.g. match a replica brush to the experimenter pantomiming brushing her hair.). In the current study, 20 month olds performance was reversed; they could match a toy brush to a real brush but not a pantomimed action.

It is hard to know how to explain this discrepancy between the studies. One possible explanation is that the ratio between the size of the replica toys and their referents played a role. The replica toys used in the current study were not quite as small as the original study and perhaps having a lower object to replica ratio facilitated younger toddlers' ability to match replica toy to its referent and see the similarity between them. Another possible explanation is that actions with toys in the current study were self-directed whereas in the original Tomasello et al. (1999) study the actions were directed both to the self and to objects. Limiting all toys to self directed actions may have been easier because of children's history of past motor experience

Meanwhile, in both studies younger and older toddlers were incapable of matching substitute toys to their referents (ie. matching a stick previously used as a toothbrush to a real toothbrush). Contrary to our predictions imitation had very little effect on children's performance in the object request condition. What is so difficult about this task?

It could be that matching substitute objects with referent objects requires more than just pretend re-presentation and that it also requires dual-representation (DeLoache, 2002; Tomasello et al., 1999). Dual representation has been used explain children's ability to translate spatial relations between scale models and full-size rooms (DeLoache, 2002). In order to engage in dual representation when a toddler "brushes" his teeth with a stick, he has to first engage in the perceptual representation of the stick in his hand, second, represent the imagined toothbrush in his mind and third, explicitly understand the relationship between them (DeLoache, 2002). It may be that pretend play only requires the first and second steps while performance on this matching task requires the third step of explicitly representing the relationship between toy and referent object. Toddlers' failure to select the correct substitute toy to match the referent object suggests that perhaps they are incapable of making this third step, creating an explicit symbolic link between the substitute toy and its referent.

Another alternative explanation is that the current structure of the task worked against toddler's abilities to match substitute toys to their referent objects. Children may have understood the task better if the experimenter had requested each substitute toy by using the name associated with the referent object. In the present study, the experimenter only asked toddlers for "this one" while holding up the referent object. Perhaps merely showing children the toy rather than saying its name confused children and prevented them from seeing the relationship between toy and referent object.

What if the experimenter had labeled the referent object instead? For example, instead of just showing toddlers the toothbrush to ask for the substitute toy, the stick, what if the experimenter had asked toddlers for a "toothbrush"? Research suggests that, given these conditions, toddlers at this age might have been able to select the correct toy (Smith, 2003). Smith and colleagues (2003) have found that by 19-22 months of age, toddlers are capable of selecting the correct substitute toy if given requesting the substitute toy with the verbal label associated with the referent. In addition to visual and motor perceptual support, labeling objects may provide an additional layer of assistance for children's pretend play representations.

Why might this be? Recent neuroscience research has given has shown that that adults' linguistic representations are frequently embodied processes (for a review see Gibbs, 2003). This may also hold true for children's linguistic comprehension. It may be that when children hear a word, in order to understand it, they need to simulate the perceptual experience associated with the world which, in turn primes them to use that representation for pretense. For example, to use the car example, if a toddler hears the word "car", he needs to simulate the visual and motor perceptual input to understand the word. This process of simulation, in turn primes him to turn any car-like object in his field of view into a substitute toy "car". Thus, manipulating language may be an additional puzzle piece in the social contextual system to support early pretend play representation.

4.8 APPLYING EMBODIED PRETEND PLAY FINDINGS

How can we apply current findings to naturally occurring play scenarios? Let's reconsider the pretend scenario described earlier: A group of toddlers, 20 and 28 months of age crowds around a caregiver on a floor scattered with replica toys and substitute toys such as a stick or block whose purpose is undefined and larger toys. What recommendations could caregivers use to bootstrap children's understanding of pretense? Under what conditions can parents or teachers assume that toddlers understand pretend play?

First, consistent with numerous studies which have suggested that early pretend play is primarily a social activity (for a review, see Rakoczy, Tomasello, & Striano, 2006), caregivers' actions with objects appear to be critical for toddlers' emergent pretend play. Thus, caregivers who want children to engage in pretense, should encourage pretense by modeling pretend play with both replica and substitute toys. In general, caregivers should also ask toddlers to perform the actions themselves. Children often do so willingly, and some even take the object out of the caregivers' hand even before the pretend play action is finished. However, even when children don't imitate pretend play actions spontaneously, encouraging them to do so will have a significant effect on their understanding of object substitution pretense.

Pretend play explorations like these occur every day in childcare classrooms, at parks, and in homes around the country and the world. Particularly in the United States there is a held belief that pretend play is not only fun and enjoyable for child and adult partners, but is also important for children's thinking (Haight & Miller, 1993; Paley, 1986) and development (Smith, 2002). Non-profits are started (www.nifplay.org, www.allianceforchildhood.net) and manifestos are written (www.udel.edu/~roberta/play/) with the mission to protect the importance of play in childhood. Childcare centers and preschools advertise their play-based curriculum (for an example, see www.coopchild.org). Authors of popular child development manuals encourage parents to pretend with their toddlers and preschoolers (Eisenberg, Murkoff, & Hathaway, 1994). Toys are marketed with claims that they will "unleash children's imaginations" (Play with a Purpose, www.pwaponline.com) As a society, we have come to believe that child's play is more than just child's play but an important way for children to learn.[2] Moreover the empirical literature on pretend play development has shown that children who engage in more frequent and complex pretend play show greater understanding in tasks of affective perspective taking, emotion understanding and "theory of mind" tasks such as false belief (Astington & Jenkins, 1995; Dunn & Cutting, 1999; Howe Rinaldi, Jennings, & Petrakos, 2002; Hughes & Dunn, 1997; Taylor & Carlson, 1997).

Perhaps the beauty of pretend play is not only that it introduces children to a world of imagination, but that it also allows for and perhaps even drives children's growing flexibility at decoupling and re-coupling of the links between motor and visual perception. What happens

[2] However, this emphasis on pretend play for children's development is not found in all cultures. For reviews see Haight (1999) and Gaskins (1999).

when the object you hold in your hand is different from the object you have pictured in your head? How visually different do they have to be before it is too difficult to make a link between them? Will moving with the object in your hand help you envision the other object in your head? What if you watch someone else perform the movement associated with the object you're trying to imagine? Is that enough to help you imagine? Pretending presents a multitude of combinations and permutations of the relationships between motor and visual perception and the work one must do to simulate one, either or both. And best of all, despite or perhaps even because of all of this complex cognitive work, children and their adult partners enjoy participating in pretend play scenarios and tasks (Haight & Miller, 1993).

4.9 FUTURE DIRECTIONS

Although the findings of the current study provide partial support for an embodied re-conceptualization of pretend play development, future research could also address unanswered questions from this current paradigm.

Younger toddlers appear not to need motor perceptual input to understand pretend play with replica objects by 20 months of age. However, motor perceptual input with replica objects might be more important for pretense re-presentation with replica objects when toddlers' very first pretend play actions emerge. If younger toddlers, 12-15 months of age could understand the demands of "feeding" Wormy, future research could address whether toddlers' earliest pretend actions with replica objects also can be supported by motor input.

Another goal of future research could be to examine further toddlers' difficulty matching substitute toys to referent objects. Earlier research by Tomasello et al. (1999) suggests that this ability might not occur until 35 months of age. As described earlier, verbal labels may help improve toddler's ability to match substitute objects and referents. This proposal needs to be tested empirically.

Furthermore, the current task could also be manipulated to address the developmental processes of decentration (Brownell & Carriger, 1991; Fenson & Ramsay, 1980, Watson & Fisher, 1977.). The direction of the pretend play actions was kept constant for the current paradigm: All actions were self-directed. However, manipulating the direction of children's actions to themselves and to others, could further articulate the ways in which action could support developing pretense re-presentation

4.10 CONCLUSIONS

Let's examine a colloquial expression. What are we really asking for when we see someone holding an object and ask, "Can I see it?" We don't want to actually look at it. We already are seeing it. If we didn't see it, we wouldn't know to ask for it. So, seeing it is clearly not what we're asking for. What we want to do is hold it. We want to feel its weight, its texture. We want to know what it feels like when we move with it. We want to turn it over, examine it and to move it by manipulate it with our hands. That is how we "see" it in a very real and full way. Our motor perception and visual perception are as tightly coupled as action and representation. This is embodied cognition.

When children pretend, they too want to hold objects and to move with them. Pretend play is a physical and active process. Toddlers do not merely sit and imagine pretend worlds without moving. Furthermore, their action is not just the mere consequence of their pretend representations. Children create and develop their capacity for pretend representations through their actions and social partners support them in this goal. This ability then opens a door into a world of possibility where any object can become something else in a child's imagination.

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